AIRCRAFT ACCIDENT REPORT 5/2008

Air Accidents Investigation Branch

Department for Transport

Report on the accident to Boeing 737-300, registration OO-TND at Nottingham East Midlands Airport on 15 June 2006

This investigation was carried out in accordance with
The Civil Aviation (Investigation of Air Accidents and Incidents) Regulations 1996

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Published 29 April 2008

Printed in the United Kingdom for the Air Accidents Investigation Branch

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Department for Transport
Air Accidents Investigation Branch
Farnborough House
Berkshire Copse Road
Aldershot
Hampshire   GU11 2HH

March 2008

The Right Honourable Ruth Kelly
Secretary of State for Transport

Dear Secretary of State

I have the honour to submit the report by Mr P T Claiden, an Inspector of Air Accidents, on the circumstances of the accident to Boeing 737-300, registration OO-TND at Nottingham East Midlands Airport on 15 June 2006.

Yours sincerely

David King
Chief Inspector of Air Accidents

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Appendix

GLOSSARY OF ABBREVIATIONS USED IN THIS REPORT

AAIB	Air Accidents Investigation Branch
aal	above airfield level
ACARS	Automatic Communications Addressing and Reporting System
ADI	Attitude Director Indicator
AFDS	Autopilot Flight Director System
agl	above ground level
AIP	Aeronautical Information Package
amsl	above mean sea level
AOC	Air Operator's Certificate
APP	Approach
ASI	airspeed indicator
ATC	Air Traffic Control
ATIS	Automatic Terminal Information System
ATS	Air Traffic Services
BHX	Birmingham
CAA	Civil Aviation Authority
CAS	Corrected Air Speed
CAVOK	Ceiling And Visibility OK (for VFR flight)
CDU	Control Display Unit
CG	centre of gravity
cm	centimeters
CMD	Command
CRM	Crew Resource Management
CVR	Cockpit Voice Recorder
CWS	Control Wheel Steering
EASA	European Aviation Safety Agency
EDP	Engine Driven Pump
EGPWS	Enhanced GPWS
EICAS	Engine Indication and Crew Alerting System
FDR	Flight Data Recorder
EMA	Nottingham East Midlands Airport
FL	flight level
FMC	Flight Management Computer
FMA	Flight Mode Annunciator
FMS	Flight Management System
ft	feet
fpm	feet per minute
g	normal acceleration
GPWS	Ground Proximity Warning System
hrs	hours (clock time as in 12:00 hrs)
hPa	hectopascal (equivalent unit to mb)
HSI	Horizontal Situation Indicator
IAS	indicated airspeed
ICAO	International Civil Aviation Organisation
ILS	Instrument landing system
kg	kilogram(s)
kg/h	kilograms/hour
km	kilometre(s)
kt	knot(s)
LOC	Localiser
LVO	Low Visibility Operations
LVP	Low Visibility Procedure
m	metres
MAC	Mean Aerodynamic Chord
MATS	Manual of Air Traffic Services
MCP	Mode Control Panel
MDH	Minimum Descent Height
METAR	Meteorological Actual Report
MHz	Megahertz
MLG	Main Landing Gear
min(s)	minutes
N_1	engine fan or LP compressor speed
nm	nautical mile(s)
OM	Operations Manual
PAPI	Precision Approach Path Indicator
PF	Pilot Flying
PNF	Pilot Not Flying
QRH	Quick Reference Handbook
RA	Radio Altimeter
RFFS	Rescue and Fire Fighting Service
R/T	Radio Telephony
RVR	runway visual range
SHFG	Shallow Fog
SOP	Standard Operating Procedure
SPECI	Special Report
SRA	Surveillance Radar Approach
TAF	Terminal Area Forecast
TOGA	takeoff/go around
UK	United Kingdom
UTC	Co-ordinated Universal Time (the contemporary equivalent of GMT)
VHF	very high frequency
VOR	VHF omni-range
°C, ºM	Degrees Celsius, magnetic

OO-TND after landing at Birmingham International Airport

Air Accidents Investigation Branch

Aircraft Accident Report No: 5/2008 (EW/C2006/06/04)

Registered Owner and Operator	TNT Airways Limited
Aircraft Type:	Boeing 737-300
Nationality:	Belgian
Registration:	OO-TND
Location of Accident:	Nottingham East Midlands Airport
Date and Time:	15 June 2006 at 0440 hrs All times in this report are UTC

Synopsis

The accident was reported to the AAIB by Air Traffic Control following the emergency landing of the aircraft at Birmingham International Airport. The investigation was conducted by:

Mr P T Claiden	(Investigator-in-Charge)
Ms G M Dean, Mr R W Shimmons	(Operations)
Mr J R McMillan, Mr M P Jarvis	(Engineering)
Mr P Wivell	(Flight Recorders)

On a scheduled cargo flight from Liège Airport to London Stansted Airport the crew diverted to Nottingham East Midlands Airport[1] due to unexpectedly poor weather conditions at Stansted. The weather conditions at EMA required a CAT IIIA approach and landing. On approach, at approximately 500 feet agl, the crew were passed a message by ATC advising them of a company request to divert to Liverpool Airport. The commander inadvertently disconnected both autopilots whilst attempting to reply to ATC. He then attempted to re-engage the autopilot in order to continue the approach.

The aircraft diverged to the left of the runway centreline and developed a high rate of descent. The commander commenced a go-around but was too late to prevent the aircraft contacting the grass some 90 m to the left of the runway centreline. The aircraft became airborne again but, during contact with the ground, the right main landing gear had broken off.

The crew subsequently made an emergency landing at Birmingham Airport (BHX).

1 Commonly known as East Midlands Airport, and referred to as EMA in this report.

The investigation determined the following:

Causal factors:

1. ATC inappropriately transmitted a company R/T message when the aircraft was at a late stage of a CAT III automatic approach.

2. The commander inadvertently disconnected the autopilots in attempting to respond to the R/T message.

3. The crew did not make a decision to go-around when it was required after the disconnection of both autopilots below 500 ft during a CAT III approach.

4. The commander lost situational awareness in the latter stages of the approach, following his inadvertent disconnection of the autopilots.

5. The co-pilot did not call ‘go-around’ until after the aircraft had contacted the ground.

Contributory factors:

1. The weather forecast gave no indication that mist and fog might occur.

2. The commander re-engaged one of the autopilots during a CAT III approach, following the inadvertent disconnection of both autopilots at 400 ft aal.

3. The training of the co-pilot was ineffective in respect of his understanding that he could call for a go-around during an approach.

One Safety Recommendation is made.

1 Factual information

1.1 History of the flight

1.1.1 Pre-departure and flight planning

The cargo flight, TAY 325N, using the callsign Quality 325N, was scheduled to depart from Liège Airport (EBLG), Belgium, on 15 June 2006 at 0234 hrs for London Stansted Airport (EGSS). Although the crew were required to report at Liège at least one hour before departure, they did so one and a half hours prior to the scheduled departure time.

The commander reviewed the flight paperwork, which included a Supplement to the UK AIP concerning major runway works at Stansted Airport and an associated Temporary Surveillance Radar Approach (SRA) procedure. The weather forecast for Stansted indicated light winds and visibility of 8 to 10 km, with a 30% probability of a temporary reduction in visibility to 4,500 m, with an associated broken cloudbase of 700 ft. The first alternate airport wasNottingham East Midlands Airport (EGNX) and the second was Liverpool Airport (EGGP). The forecast weather for each of these was good.

The fuel required for the flight according to the flight plan was 5,514 kg. The actual cargo load was such that extra fuel capacity was available, so the crew decided on a fuel load of 7,500 kg.

1.1.2 Liège to Stansted

The commander was the Pilot Flying (PF) for the flight to Stansted and, in accordance with company procedures, the co-pilot made the communications with ATC. At 0312 hrs, the aircraft took off from Runway 23L at Liège in conditions of 200 m meteorological visibility; the Runway Visual Range (RVR) at the threshold was 1,200 m. The flight towards Stansted was uneventful and on arrival in the London area, at 0344 hrs, the crew reported to Essex Radar, on frequency 120.625 MHz, that they had received Stansted ATIS information 'Q'; this ATIS code indicated a visibility of 6 km. However, Essex Radar advised the crew that ATIS information 'R' was now in force, giving a visibility of 4,900 m in mist. Additionally, the controller informed the crew that there were reports of fog approaching Stansted Airport and that the touchdown RVR was showing 1,000 m. This was less than the 2,000 m minimum required to make the temporary SRA approach. As the commander considered that the weather might improve after sunrise, due to occur at 0340 hrs, 'Quality 325N' was cleared to enter the hold at LOREL[1] at 6,000 ft amsl.

1 LOREL is located 13 nm to the northwest of Stansted Airport.

Whilst in the hold, the crew maintained regular contact with Essex Radar to obtain updates on the weather situation at Stansted. At 0355 hrs, they advised that they had sufficient fuel to remain in the hold for 35 minutes (from 0355 hrs) and were aware that the visibility at Stansted was continuing to decrease. At 0401 hrs, ATC informed them that the RVR was now between 650 m and 350 m. By now, the crew were awaiting information from their company as to the preferred alternative destination should they have to divert. The commander had sent a message through ACARS[2] but had not received a reply, so he contacted the handling organisation at Stansted and requested that they call the company operations at Liège to ask for the information.

At 0403 hrs, the crew recalculated their fuel endurance and advised Essex Radar that they were able to hold for another 35 minutes and that they were awaiting company information on the preferred alternate. They also requested a weather update for EMA. Within two minutes, Essex Radar informed them that the latest report was that Runway 09 was in use with a visibility of 2,000 m in haze, cloud scattered at 200 ft and broken at 300 ft agl. The pilots then asked for an update on the weather at Liverpool Airport. By 0408 hrs, Essex Radar informed them that Runway 09 was in use and the surface wind was 180º/ 04 kt. Visibility was greater than 10 km, cloud was few at 300 ft agl, the air temperature was +14ºC and dew point was +10ºC. ATC also requested that the crew provide a couple of minutes warning of any decision to divert; the co-pilot acknowledged this request and stated that their preferred diversion was EMA. This later information was based on the company response to the commander's earlier question, which had now been received.

1.1.3 Stansted to Nottingham East Midlands Airport

At 0419 hrs, the crew asked Essex Radar to check whether Runway 27 would be available at EMA for a CAT IIIA approach, as the weather appeared to be deteriorating. About this time, EMA was in the process of changing to the westerly runway due to the weather conditions and Essex Radar informed 'Quality 325N' of this change at 0421 hrs. At the same time, they informed the crew that the RVR at EMA was now 400 m in the runway touchdown zone, 650 m in the mid-zone and 900 m in the end-zone. The co-pilot responded with a request to divert to EMA. The pilots agreed that they would attempt an approach to EMA, in accordance with the company preference, as sufficient fuel would remain to continue to Liverpool Airport should the approach have to be abandoned.

2 Aircraft Communication Addressing and Reporting System.

Essex Radar cleared ‘Quality 325N’ to climb to FL100 and to fly direct to ‘VELAG’[3]. At 0423 hrs, the aircraft was transferred to London Control (Welin sector) on frequency 130.925 MHz. The co-pilot had some difficulty in finding the approach charts for ‘East Midlands’, which were filed in their chart books under N for ‘Nottingham East Midlands’. During the transit, the commander carried out an approach briefing, which included the possibility that a CAT IIIA approach might be required. At 0430 hrs, the controller instructed the crew to turn right onto a heading of 360º and to descend to FL80. They were also transferred to EMA Approach on frequency 134.175 MHz.

On initial contact, the aircraft was identified and the instruction: “MAKE THE HEADING ZERO ZERO FIFE PLEASE AND ITS VECTORS TO THE ILS LANDING RUNWAY TWO SEVEN INFORMATION IS KILO AND RVR THREE FIVE ZERO SEVEN HUNDRED FOUR HUNDRED” was given. The co-pilot acknowledged ATIS information Kilo. At 0433 hrs, the controller advised the crew that they were 21 nm from touchdown and cleared them to descend to an altitude of 3,000 ft on the QNH of 1023 hPa and this instruction was acknowledged by the co-pilot. By 0435 hrs, the controller confirmed that all the lighting appropriate to a CAT IIIA approach was illuminated. ‘Quality 325N’ was then cleared to descend to 2,000 ft and, by 0437 hrs, the co-pilot called that they were established on the localiser. They were then cleared to descend with the ILS and transferred to Tower on frequency 124.0 MHz.

1.1.3.1 Final approach at Nottingham East Midlands Airport

After checking in with Tower, the following clearance was given: “QUALITY THREE TWO FIVE NOVEMBER CLEAR TO LAND RUNWAY TWO SEVEN THE WIND IS SOUTH-EASTERLY TWO KNOTS RVR THREE FIVE ZERO FIVE HUNDRED THREE FIVE ZERO”. The co-pilot responded: “CLEAR FOR A LANDING RUNWAY TWO SEVEN QUALITY THREE TWO FIVE NOVEMBER”. Approximately one minute later the co-pilot asked for, and was again given, confirmation that they were clear to land. Around this time, the crew had completed their landing checks for a CAT IIIA landing, with the landing gear extended and Flap 40 set.

With the aircraft at about 500 ft aal and within 2 nm of the runway, the controller made the following transmission: “THREE TWO FIVE NOVEMBER I’VE BEEN INSTRUCTED THAT YOU ARE NOT TO LAND HERE FROM YOUR OPERATION OP-OPERATIONAL AUTHORITY AT YOUR DISCRETION YOU MAY GO ROUND”. There was then a delay of approximately 10 seconds before the commander responded with: “TALKING TO THREE TWO FIVE NOVEMBER?”

3 VELAG is a reporting point some 56 nm to the northwest of Stansted Airport.

Up to this point, the co-pilot had been operating the radio. The controller immediately responded with: "THREE TWO FIVE NOVEMBER CLEAR TO LAND" and this was acknowledged by the commander.

Meanwhile, the co-pilot had been monitoring the instrument annunciations. He heard the aircraft automatic call of "FIVE HUNDRED" and made the SOP 'five hundred feet' call to the commander, but he did not register the call from ATC. With no response from the co-pilot, the commander was not sure whether the ATC message was for his aircraft and, if so, what it meant. He attempted to respond to ATC himself but he inadvertently pressed the autopilot disconnect button as he started to speak so that both autopilots disconnected and the autopilot disconnect warning sounded. He then located and pressed the transmit button and also tried to re-engage the autopilots by moving both autopilot paddle switches on the Mode Control Panel (MCP) to the CMD position; one switch eventually latched in position. As he was doing so, and without him noticing, the aircraft began to deviate above the glideslope and track to the left of the localiser.

The co-pilot noticed that the autopilot had disconnected and saw the commander attempt to re-engage it. He then observed that the aircraft was going above the glideslope and pointed this out to the commander by saying "ONE DOT HIGH". With no response, he said in French, 'we need to descend'.

Shortly afterwards, the EGPWS sounded a SINK RATE PULL UP warning and the commander looked up and saw 'green' filling the front windscreen. He disconnected the autopilot, selected Take Off Go Around (TOGA) mode and made an aft control wheel input. Almost immediately, the aircraft hit the ground; this was followed by a short period of extreme confusion. The co-pilot then called out "ATTEND ATTEND GO-AROUND". Neither pilot could remember the exact sequence of events after ground contact; each had the impression that they were handling the controls during the subsequent lift-off. However, soon after they were airborne and climbing, the commander called: "I HAVE CONTROL". The pilots were aware that the aircraft had suffered some damage as the landing gear unsafe warning horn was sounding and one landing gear red light indication was showing. As the 'split flaps' indication was also showing, they decided not to attempt to change the aircraft's configuration.

Within the Tower, the controller heard an aircraft going around and the sound of a transmitter being switched, but with no communication. He transmitted: "QUALITY THREE TWO FIVE NOVEMBER I HEAR YOU HAVE GONE ROUND AND ER WAS THAT BECAUSE OF THE REASONS I GAVE YOU OR BECAUSE OF THE

WEATHER". Initially the co-pilot asked the controller to standby and then responded with: "ER YES WE HAVE ER TOUCH ER THE GROUND AND ER WE REQUEST ER ER STANDBY". In the background to these later transmissions, the sound of an audio alarm could be heard. Shortly after this, the crew asked for a diversion to Liverpool. The controller responded with an explanation of the message that he had passed to the crew prior to landing and he completed this transmission with the instruction for 'Quality 325N' to climb to 4,000 ft.

The approach controller, who was also the Watch Supervisor, had also listened to the transmission from the aircraft and was concerned that the inclusion of the word 'standby' related to an emergency situation rather than asking the controller to standby for a further message. He was therefore prepared to accept the aircraft quickly when, at 0443 hrs, the commander made the following transmission: "QUALITY THREE TWO FIVE NOVEMBER MAYDAY MAYDAY MAYDAY WE HAVE BIG PROBLEMS WE HAVE ER WE HAVE TO MAINTAIN THREE THOUSAND FEET WE HAVE ONE UNSAFE ER GEAR AND WE HAVE FLAP PROBLEMS WE NEED ER WE ARE OF A LOW FUEL STATUS THREE THOUSAND KILOS AND ER WE NEED YOU TO DIRECT US TOWARDS AN AIRCRA- AN AIRFIELD WHERE WE HAVE CAVOK DECLARING FULL EMERGENCY". During this transmission, the approach controller advised the tower controller to transfer the aircraft to the approach frequency. The tower controller acknowledged the 'MAYDAY' message and instructed the aircraft to maintain heading and to change to the approach frequency.

1.1.4 Nottingham East Midlands to Birmingham Airport

The co-pilot checked in on the new frequency and the crew then reviewed the status of the aircraft. There were a number of warnings and cautions, displayed on the Electronic Indicating Crew Alerting System (EICAS) or by discrete lights, in particular, GEAR UNSAFE, LOSS OF HYDRAULIC SYSTEM A, SPLIT FLAPS, and an AFT CARGO DOOR light. Responding to the landing gear unsafe warning, the co-pilot made a number of attempts to carry out the MANUAL GEAR EXTENSION procedure, in accordance with the Quick Reference Handbook (QRH), but these were not successful. The commander also tried pulling the gear release handle, but without success. He then decided not to action all the other possible QRH procedures but to concentrate instead on landing the aircraft as soon as possible. He was experiencing some control difficulties, in particular in maintaining the aircraft's wings level.

Once the crew had contacted the EMA Approach again, the controller confirmed the aircraft's position as 8 miles west of the airport and instructed the crew to maintain an altitude of 3,000 ft. The crew confirmed the aircraft's endurance as a maximum of 35 minutes and repeated that they needed an airfield with unrestricted visibility. They were then instructed to turn left onto a heading of 230º for radar vectors to Runway 15 at Birmingham Airport, where the weather was CAVOK. By 0445 hrs, the controller informed the crew that they had "THIRTY TRACK MILES TO GO TO BIRMINGHAM" and asked them to confirm the extent of their problems. In response, the commander stated: "ERR THREE TWO FIVE NOVEMBER WE HAVE ER RIGHT UNSAFE GEAR WE HAVE SPLIT FLAPS AT FORTY WE HAVE A LOW FUEL STATUS AND WE HAVE AN HYDRAULIC PROBLEM WE DO NEED MAXIMUM ASSISTANCE AND WE WOULD LIKE TO HAVE ER FULL EMERGENCY ON THE GROUND WITH ER THE FIRE BRIGADE ON STANDBY". The controller confirmed that Birmingham Airport was being informed and that Runway 15 was in use. By 0447 hrs, the aircraft had been transferred to Birmingham Approach on frequency 118.050 MHz.

The crew prepared for an ILS approach to Runway 15 at Birmingham. On initial contact with Birmingham Approach, they confirmed "MAYDAY" and requested a descent for the landing on Runway 15. The controller cleared the aircraft to descend to an altitude of 2,500 ft on the QNH of 1023 hPa and advised the crew that: "THE ILS HAS COME ROUND TO ONE FIVE BUT WE HAVE NO GLIDE PATH IT'S A LOCALISER ONLY[4] APPROACH". The commander immediately responded that they required a full ILS and the controller transmitted that they would "TRY TO TURN THE ILS ROUND AGAIN"[5]. However, the glide path signal for the ILS on Runway 15 would still not function and, therefore, the controller offered the crew the option of either a surveillance radar approach on Runway 15 or a full ILS to Runway 33. After checking the track miles to go to each runway (35 nm to Runway 33, 13 nm to Runway 15), the commander stated that he wanted an ILS to Runway 33. During the next three minutes, the controller continued to provide radar headings and also established from the crew the aircraft's fuel endurance and the number of persons on board. The co-pilot checked the NOTOC[6] and passed information to ATC that part of the aircraft's cargo was dry ice and pyrotechnics. The crew reiterated that they needed to be on the ground as soon as possible.

At 0451 hrs, the controller informed the crew that there was a police helicopter airborne over Birmingham city and it was available to check on the state of OO-TND's landing gear as the aircraft flew past. The crew accepted this offer and were turned, initially, onto a radar heading of 170º. By 0454 hrs, the police helicopter was visual with the aircraft to its left and, at 0456 hrs the controller

4 This is understood to have meant a Localiser/DME approach (LOC/DME).
5 ie, make another attempt to bring the full ILS for Runway 15 on-line.
6 NOTOC - Notice to captain relating to [hazardous] cargo.

advised the crew of the helicopter pilot's report: "……THE NOSEWHEEL AND THE PORT SIDE ARE DOWN HOWEVER THE STARBOARD UNDERCARRIAGE APPEARS UP". Once the crew acknowledged the receipt of this message, the controller also transmitted: "AND THREE TWO FIVE NOVEMBER THE POLICE HELICOPTER HAS LOOKED CLOSELY WITH HIS ER CAMERA EQUIPMENT AND THE STARBOARD GEAR APPEARS UP". The crew prepared for a landing on Runway 33. They were now certain that the right main landing gear (MLG) was not down and the co-pilot carried out the PARTIAL GEAR UP LANDING checklist from the QRH, Appendix A. The commander made a further, unsuccessful, attempt to lower the gear using the manual system.

The controller continued to provide radar vectors to the aircraft and, at 0459 hrs, the crew asked the controller to confirm that: "……FIRE BRIGADE IS ON STANDBY". After the controller had informed the crew that: "……WE HAVE A FULL TURNOUT FOR YOU", the crew acknowledged this and added: "……..JUST FOR CONFIRMATION WE ARE MISSING THE GEAR ON THE RIGHT HAND SIDE AS YOU REPORTED EARLIER". By 0500 hrs, the aircraft had been cleared to land on Runway 33 with a surface wind of 100º/less than 5 kt.

The aircraft touched down just to the left of the runway centreline and came safely to a stop on the centreline at 0602 hrs, Figure 1.

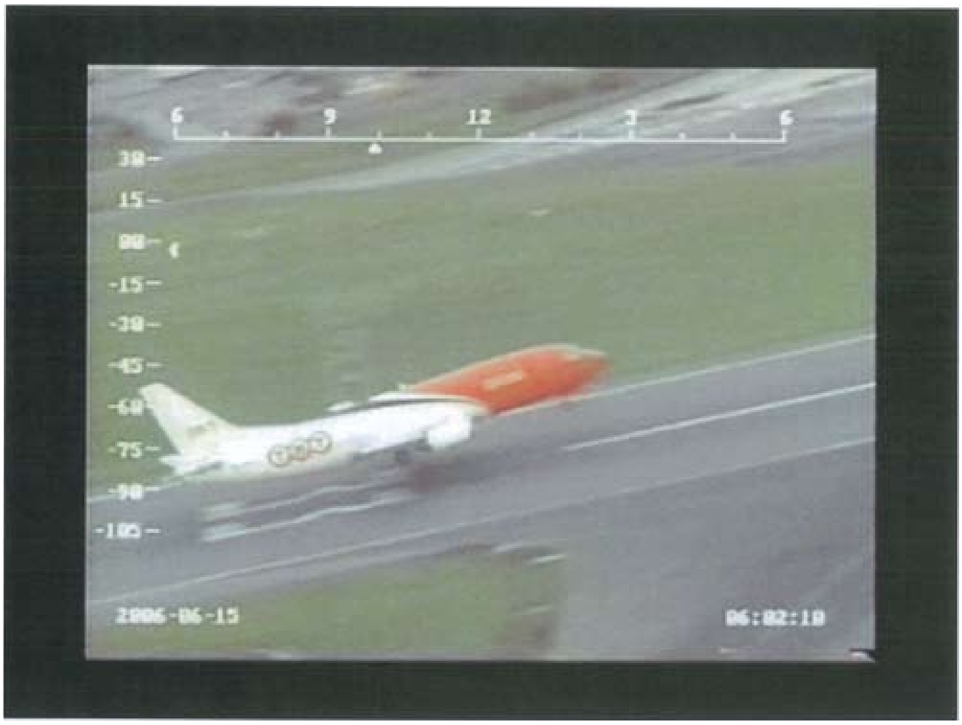


Figure 1

OO-TND about to touch down on Runway 33 at Birmingham

The Aerodrome Rescue and Fire Fighting Service (RFFS) arrived quickly at the aircraft and laid a foam blanket under the right engine. Thin smoke was evident behind the aircraft, which soon dispersed. RFFS personnel assisted the crew to disembark from the left forward entry door of the aircraft.

1.2 Injuries to persons

Injuries	Crew	Passengers	Others
Fatal	None	N/A	None
Serious	None	N/A	None
Minor/none	2	N/A	None

1.3 Damage to aircraft

1.3.1 Nottingham East Midlands Airport

As a consequence of the aircraft hitting the ground, the complete right landing gear leg assembly had detached from the aircraft at its 'fuse pin' attachment points in the wing. As a result, hydraulic System A was lost. The leg was found on the grass within the sterile[7] area to the left of Runway 27. The detached leg had caused significant damage to the right inboard flap assembly, and some damage to the right lower rear fuselage structure around the rear baggage hold door. Structural damage had also been caused to the two flap track fairings on the right outboard flap, the underside of the right engine nacelle and the right wing tip.

1.3.2 Birmingham International Airport

In the absence of the right MLG, additional damage to the underside of the right engine nacelle occurred as it slid along the surface during the landing roll.

1.4 Other damage

None.

7 This is an area classified as sterile during low visibility operations, due to the proximity of the ILS installation, which is kept free from any equipment/vehicles which may influence the accuracy, in this case, of the ILS glideslope signal.

1.5 Personnel information

1.5.1 Commander

Male:	Aged 42 years	
Licence:	Airline Transport Pilot's Licence	
Aircraft ratings:	Boeing 737	
Licence Proficiency Check:	Valid to 28 February 2007	
Operator Proficiency Check:	Valid to 31 August 2007	
Line check:	Valid to 25 March 2007	
Most recent Cat IIIA approach	20 February 2006 (aircraft)	
Medical certificate:	Class 1 renewed 31 March 2006	
Flying experience:	Total all types:	8,325 hours (incl. 4,000 hours as Flight Engineer)
	Total on type	4,100 hours
	Total last 90 days	85 hours
	Total last 28 days:	37 hours
	Total last 24 hours:	5 hours
Previous rest period:	12 hours 14 min	

The commander had been promoted within the company, having previously been a co-pilot; he completed his command qualification on 9 February 2006.

1.5.2 Co-pilot

Male:	Aged 35 years	
Licence:	Airline Transport Pilot's Licence	
Aircraft ratings:	Boeing 737	
Licence Proficiency Check:	Valid to 31 March 2007	
Operator Proficiency Check:	Valid to 30 September 2007	
Line check:	Valid	
Most recent Cat IIIA approach:	16 March 2006 (simulator)	
Medical certificate:	Class 1 renewed 4 April 2006	
Flying experience:	Total all types:	1,674 hours
	Total on type:	1,377 hours
	Total last 30 days:	19 hours
	Total last 24 hours:	4 hours
Previous rest period:	16 hours 36 min	

Both pilots were Belgian nationals. The commander had an excellent command of English; the co-pilot's English was more limited.

1.5.3 Flight crew duty schedule

The operator's scheme for flight time limitations was established in accordance with the requirements of the Belgian Civil Aviation Authority.

The commander had been rostered to commence his duty period at 1815 hrs, 14 June 2006, at Istanbul Airport, Turkey. This followed a rest period of 12 hours and 14 minutes. He later reported that he was not able to sleep well before commencing duty, and was affected by tiredness at the time of the accident flight. The allowable flying duty period following his reporting at Istanbul was 14 hours. At the time of the accident at East Midlands he had completed 10 hours, 25 minutes of flying duty period and, on completion of the flight to Birmingham, 10 hours and 45 minutes.

The co-pilot commenced his duty in Vienna, Austria, at 1925 hrs on 14 June 2006. His rest period beforehand was 16 hours 36 minutes. Following his reporting for duty he had an allowable flight duty period of 14 hours. At the time of the accident he had completed 9 hours 15 minutes of flying duty period and, on completion of the flight to Birmingham, 9 hours and 35 minutes.

1.5.4 EMA Radar Controller

Male:	Aged 56 years
Licence:	Air Traffic Control
Initial date of issue:	CAA: 1971. JAA: 2003
Current endorsements:	Aerodrome Control Instrument Rating (ADI) valid until 1 June 2007. Initially validated at East Midlands Airport in 1977
	Approach Surveillance – Radar Rating (APS) valid until 1 June 2007. Initially validated at East Midlands Airport in 1977
	On-Job-Training-Instructor (OJTI)
	Watch Supervisor
Medical certificate:	Class 1 valid until 31 August 2006
Start time on shift:	14 June 2006 at 2050 hrs
Start time on duty as APS:	15 June 2006 at 0300 hrs

1.5.5 EMA Tower Controller

Male:	Aged 53 years
Licence:	Air Traffic Control
Initial date of issue:	RAF: 1973. CAA: 1982. JAA: 2003
Current endorsements:	Aerodrome Control Instrument Rating (ADI) valid until 30 January 2007. Initially validated at East Midlands Airport in 1993
Approach Surveillance:	Radar Rating (APS) valid until 30 January 2007. Initially validated at East Midlands Airport in 1994
	On Job Training Instructor (OJTI)
Medical certificate:	Class 1 valid until 30 November 2006
Start time on shift:	14 June 2006 at 2050 hrs
Start time on duty as ADI:	15 June 2006 at 0300 hrs

1.6 Aircraft information

1.6.1 General description

OO-TND was manufactured in 1987 and converted to a freighter in 2004, which included the fitting of a large freight door on the left side of the forward fuselage to enable cargo pallets to be carried.

1.6.2 Leading particulars

Manufacturer:	Boeing Commercial Airplane Company
Type:	B737-301SF
Aircraft Serial Number:	23515
Year of manufacture:	1987
Year of modification to freighter:	2004
Powerplants:	Two CFM International CFM56 3B turbofan engines
Total airframe hours:	45,832 at 15 June 2006
Total airframe cycles:	34,088 at 15 June 2006
Certificate of Airworthiness	
Date of issue:	14 December 2005
Issuing Authority:	Kingdom of Belgium CAA
Certificate of Registration No:	5443

1.6.2.1 Weight and balance

Departure Fuel:	7,500 kg
Landing Fuel EGNX:	3,200 kg
Landing fuel EGBB:	1,930 kg
Maximum takeoff mass:	61,234 kg
Actual takeoff mass:	49,703 kg
Takeoff Centre of Gravity:	17.22 % MAC
Maximum landing mass:	51,709 kg
Estimated landing mass at EGNX:	45,673 kg
Estimated landing mass at EGBB:	43,628 kg (44,473 kg less 845 kg, the mass of the right main gear and actuator)

The aircraft Centre of Gravity (CG) was within the normal range throughout the flight.

1.6.3 Engines

No 1 engine:	CFM International CFM56-3B2
Serial number:	721693
Engine installation hours:	42,639 hours at 15 June 2006
Engine installation cycles:	29,713 hours at 15 June 2006

No 2 engine:	CFM International CFM56-3B2
Serial number:	721690
Engine installation hours:	41,318 hours at 15 June 2006
Engine installation cycles:	29,873 hours at 15 June 2006

1.6.4 Flight instruments

The aircraft was equipped with a Flight Management System (FMS). Information from this was used for some of the flight instrument displays. The pilots interfaced with the Flight Management Computer (FMC) through two Control Display Units (CDU) and a Mode Control Panel (MCP). The Attitude Director Indicator (ADI) and a Horizontal Situation Indicator (HSI) for both pilots were electro-mechanical units, and information derived from an ILS could be presented on both types of instrument. Two ILS receivers were installed, with frequency selection on both being controlled manually. Radio Altimeter (RA) displays were located to the right of the pressure altimeter on each pilot's instrument panel. Photographs of the two flight instrument panels are shown at Figures 2a and 2b.

Figure 2a

Commander's flight instrument panel

Figure 2b

Co-pilot's flight instrument panel

1.6.4.1 Instrument comparator

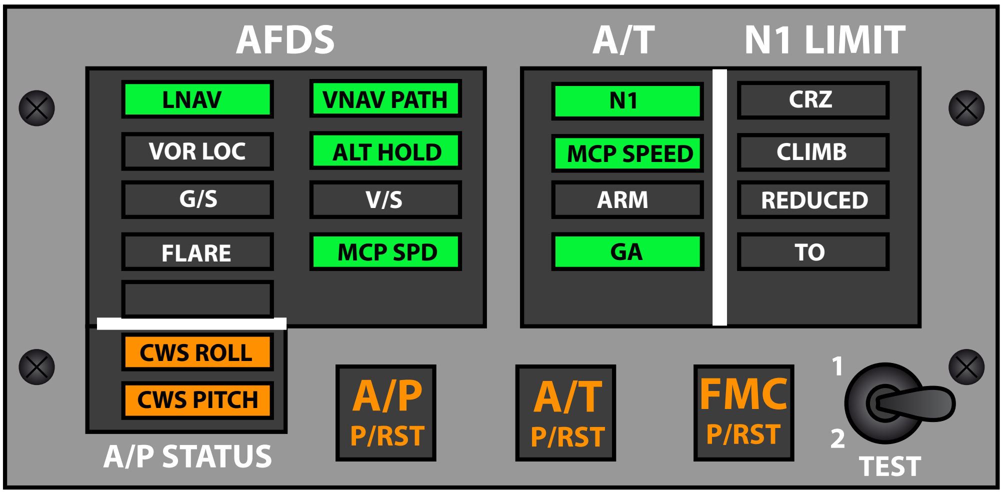
The aircraft was equipped with a flight instrument comparator system, designed to provide a warning to the flight crew should any discrepancy occur between the left and right displayed heading, pitch or roll attitudes, or localiser or glideslope deviation outside specified limits. The system illuminates a light on both indicator panels, which are located directly above each pilot's ADI; no audible warning is sounded.

1.6.5 Autopilot Flight Director System (AFDS)

The aircraft was configured with two Autopilot Flight Control Computers, referred to as Channels A and B, which by means of paddle switches on the MCP. The design of this system is such that each channel may be engaged separately, but only one at any one time, unless the Approach (APP) mode is armed; engaging the second channel trips out the first one. With the APP mode engaged, dual channel operation is allowed and provides autopilot control for an autoland comprising the approach, the landing flare and touchdown, or automatic go-around. There are three possible positions for the paddle switches; CMD, CWS and OFF, these being Command, Control Wheel Steering and Off, respectively. The two paddle switches latch into position when engaged. The flight directors are separately selected by switches on the MCP.

The AFDS may be engaged in a number of different modes by means of mode selector switches, also located on the MCP. The AFDS armed and engaged pitch and roll modes are displayed on a section of the Flight Mode Annunciator Panel, a separate panel of electromagnetic indicators incorporated at the top of each pilot's instrument panel, Figure 3. This panel also incorporates autopilot status indications for when the autopilot is not engaged in CMD mode.

When in CMD mode, the autopilot will control the aircraft's vertical and lateral flight path according to the engaged mode(s). With CWS mode engaged, the autopilot manoeuvres the aircraft in response to manually applied pressure on either pilot's control wheel/column. If the control pressure is released the autopilot will then maintain the aircraft's existing attitude, unless the roll pressure is released with less than six degrees of bank angle, in which case the autopilot rolls the wings level and maintains the aircraft's heading. However, when a paddle switch is latched in the CMD position but the autopilot has defaulted to CWS mode and the bank attitude is less than 6 degrees, the roll mode holds the existing heading.



White - armed
Green - engaged

N_1 information
White - engaged

Figure 3

Flight Mode Annunciator (FMA) panel, showing some of the modes

Whenever an autopilot engage paddle switch is selected, but without a pitch or roll mode being selected, then the switch will latch in the CMD position. In this circumstance, the autopilot mode will default to CWS and the CWS R and CWS P legends will illuminate on the status panel. When the autopilot is operating in CWS mode with the paddle switch in the CMD position, and the APP mode is armed, the autopilot can intercept a localiser. As the localiser course is intercepted, the autopilot status annunciation CWS ROLL disappears and VOR/LOC appears.

Whenever a paddle switch is latched in the CMD position and the autopilot is operating in CWS mode, the roll mode logic differs slightly from when the paddle is latched in the CWS position.

1.6.6 All weather capability

With the dual channel autopilot system fitted to OO-TND, the aircraft was approved for CAT IIIA automatic landings with a Minimum Decision Height (MDH) of 50 ft and a minimum RVR of 200 m. The most recent CAT IIIA approach and landing made by the aircraft was carried out on 7 April 2006 and this was logged as '*satisfactory*' in the 'Auto-approach and Auto-land Monitoring Sheet'.

For a CAT IIIA automatic approach and landing, dual autopilot operation in APP mode is required. Both VHF NAV receivers must be tuned to the ILS frequency and both autopilot channels must be selected to the CMD position, prior to 800 ft RA height. After localiser and glideslope capture, APP mode may only be disengaged by using an autopilot disengage switch, by pushing a TOGA switch or by retuning a VHF/NAV receiver. If disengaged, the paddle switches will drop back from the CMD position to the OFF position, a flashing red warning light on the FMA panel will activate and a warning tone will sound. If below approximately 800 ft RA, it is not possible to re-engage both autopilots; one may be re-engaged, but the automatic land function is disabled.

1.6.7 Warning systems

1.6.7.1 Enhanced Ground Proximity Warning System (EGPWS)

Although the aircraft was EGPWS equipped, because the aircraft was equipped with electro-mechanical flight instruments, no terrain display was available to the crew.

1.6.7.2 Landing gear warning system

An aural warning is triggered whenever the lever is selected to DOWN and the landing gear is not extended and locked, and the wing flaps are in landing mode, and/or one throttle lever is retarded and the flaps are not up. The warning is deactivated when all landing gears are down and locked.

1.6.8 Hydraulic systems

Two main hydraulic systems, identified as A and B, and a standby system provide power to various services on the aircraft. System A is pressurised by an engine driven pump (EDP) on the left engine and an electric motor driven pump. System B is similarly powered, but the EDP is driven by the right engine. The standby hydraulic system uses an electric motor driven pump to provide hydraulic pressure should a loss of pressure occur in system A or B, or whenever manually activated.

The normal wheel brake system is powered from System B; the alternate brake system is powered from System A. As the System A and B hydraulic lines on the landing gear are relatively vulnerable to damage, to prevent depletion of hydraulic fluid in the event of a line rupture, hydraulic fuses are installed between the anti-skid units and the brakes. These fuses are located in the MLG wheel wells.

System A is the primary source of power for landing gear retraction. In the event of loss of System A pressure a landing gear transfer valve automatically transfers this function to System B, which enables the gear to be retracted following the loss of the left engine on takeoff. There are no hydraulic fuses to protect System A in the event of a landing gear leg becoming detached from the aircraft.

Some aircraft services powered by hydraulic System A have no alternative source of power. These are the outboard spoilers, ground spoilers and nose gear steering systems. Therefore, in the event of the loss of System A, these services will be lost. In a situation where the hydraulic fluid is lost, such as would occur following detachment of the leg, the ability to retract the remaining landing gear legs would also be lost.

The trailing edge flaps are powered by System B, with a backup capability from System A. An alternate flap operating system, electrically powered, may be used; this is required to be armed and a separate control used to extend or retract the flaps. Although a flap asymmetry detection system is fitted, designed to freeze the flaps position if a difference of more than a few degrees between the left and right trailing edge flap positions is detected, this does not prevent their movement using the alternate system.

1.6.9 Main landing gear attachment

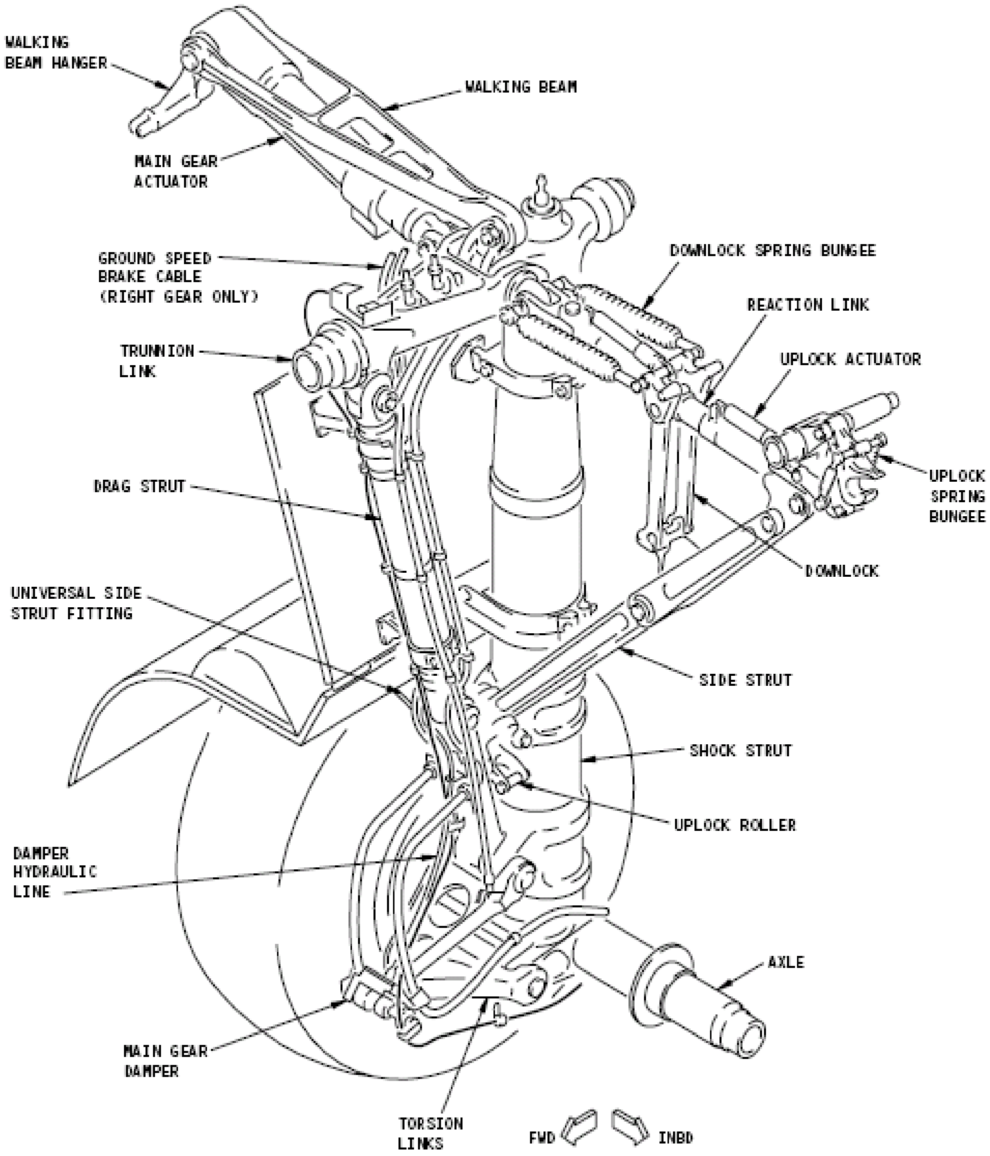
The Main Landing Gear Assembly is shown in Figure 4.

The main gear leg assembly is principally attached to the wing via two trunnion bearings; the forward trunnion bearing is attached to the rear spar and the aft trunnion bearing to the main landing gear beam. Both of these trunnion bearing assemblies contain a fuse pin and are designed to fail if the landing gear receives a severe impact, thus maintaining the structural integrity of the wing structure. The main gear assembly is also attached to the fuselage at the outboard end of the walking beam/main gear actuator and, when retracted, at the up-lock mechanism.

1.6.10 Engine nacelle attachment

The engine nacelle and pylon assemblies are attached to the wing by a series of fuse pins, designed to fail in the event of abnormal loads being applied to the nacelle. The design is intended to preserve the wing structure, where fuel and control systems are located, and allow the engine assembly to separate cleanly in such circumstances.

BOEING
737-300/400/500
MAINTENANCE MANUAL



Main Gear Component Location

Diagram courtesy of Boeing

Figure 4

Main landing gear (left shown)

1.6.11 Maintenance information

A review of the maintenance records revealed nothing of significance with respect to this accident. The automatic approach and autoland operational status sheet showed that the aircraft's clearance had been reduced to CAT I status on 6 May 2007, but that it was upgraded back to CAT III (MDH 50 ft aal, RVR 200 m), on 15 June 2007.

1.7 Meteorological information

1.7.1 General

The synoptic situation on the morning of 15 June 2006 showed a ridge of high pressure covering the British Isles with areas of low/medium level cloud over central and southern England. The upper winds between 2,000 ft and 10,000 ft were from a north or north-easterly direction at between 5 kt and 15 kt.

The planned flight schedule was from Liège to London Stansted with an onward sector to Edinburgh. The weather forecast available to the crew in the pre-flight briefing included forecasts and actual meteorological reports for the destinations and the planned alternates, as follows:

1.7.2 London Stansted Airport

The Terminal Area Forecast (TAF) for Stansted valid from 0100Z to 1000Z was:

> *'Surface wind from 020/8kt, visibility more than 10km, scattered cloud at 1,500 ft TEMPO[8] from 0200Z to 0800Z, visibility 8km, broken cloud at 1,000 ft PROB 30 TEMPO from 0400Z to 0700Z, visibility 4500m, mist, broken cloud at 700 ft'*

The 0320Z METAR at Stansted was:

> *'Surface wind from 340/4kt, visibility more than 6,000 m, few cloud at 8,000 ft temperature 9C, dewpoint 9C, QNH 1021mb'*

8 TEMPO a period of temporary fluctuations to the forecast meteorological conditions which may occur at any time during the period given. The conditions advised are expected to last less than one hour in each instance and in aggregate less than half the period indicated.

The 0350Z METAR at Stansted was:

> *'Surface wind from 340/4kt, visibility 400m, RVR Runway 23 450m, partial fog, scattered cloud at the surface, temperature 9C, dewpoint 9C, QNH 1021mb'*

1.7.3 Nottingham East Midlands Airport

At EMA there was an automated system for the measurement and recording of RVR information. With this system, if the value fell to 1,500 m or less, then the RVR would automatically be included in the EMA ATIS. The METARs were compiled by a qualified observer; RVR values, if appropriate, would need to have been entered manually. However, in April 2007, the Met reporting system was upgraded and now provides for automatic reporting of meteorological information, including RVR data.

The first recorded deterioration of visibility at EMA was at 0330 hrs when the touchdown RVR for Runway 09 reduced to 800 m.

The forecast and actual conditions are presented below in sequential order.

The TAF for EMA, the planned alternate for Stansted, issued at 0003Z and valid from 0100Z to 1000Z, was as follows:

> *'Surface wind from 040/4kt, visibility more than 10km, few cloud at 4,800 ft PROB 30 TEMPO from 0400Z to 0800Z, visibility 8km, broken cloud at 900 ft'*

At 0307 hrs a new TAF was issued valid from 0400 hrs to 1300 hrs:

> *'Surface wind from 080/3kt, visibility more than 10km, few cloud at 4,800 ft PROB 40 TEMPO from 0400Z to 0800Z, visibility 6km, broken cloud at 600 ft'*

The 0350Z METAR was:

> *'Surface wind from 070/5kt, visibility more than 10km, scattered cloud at 500 ft, temperature 9C, dewpoint 8C, QNH 1023mb'*

ATIS information Charlie broadcast at 0350 hrs was:

> *'Surface wind from 070/5kt, visibility 12km, scattered cloud at 500 ft, temperature 9C, dewpoint 8C, QNH 1023mb'*

RVRs were recorded automatically and, at 0350 hrs, were:

> *'R09 threshold 800m, mid-point more than 1,500m, stop end 1,300m'*

The 0420Z METAR was:

> *'Surface wind from 110/4kt,variable between 070 and 140, visibility 1,600 m, haze, scattered cloud at 200 ft, broken cloud at 300 ft temperature 9C, dewpoint 8C, QNH 1023mb'*

ATIS information Hotel broadcast at 0420 hrs was similar to the 0420Z METAR.

The RVR recorded at 0420 hrs was:

> *'R09 threshold 900m, mid-point 650m, stop end 400m'*

At 0434 hrs a new TAF was issued valid from 0400 hrs to 1300 hrs:

> *'Surface wind from 080/3kt, visibility more than 10km, few cloud at 4,800 ft TEMPO from 0400Z to 0800Z, visibility 1,600 m, broken cloud at 300 ft'*

This TAF indicated a visibility of greater than 10 km, although the touchdown RVR reported by ATC to the crew at this time was 350 m. The TAFs issued by the Met Office were updated using the RVR information at 0506 hrs.

ATIS information Kilo broadcast at 0430 hrs was acknowledged as received by the crew at 0433 hrs:

> *'Surface wind variable 2 kt, visibility 400 m, RVR R27 300m, RVR R09 300m, fog, scattered cloud at 100 ft, broken cloud at 200 ft temperature 9C, dewpoint 8C, QNH 1023 mb'*

RVRs recorded at 0439 hrs, the time the aircraft contacted the ground, were:

'R27 threshold 350, mid-point 500m, stop end 350m'

At 0506 hrs a new TAF was issued valid from 0400 hrs to 1300 hrs:

'Surface wind from 080/3kt, visibility 400 m in fog, broken cloud at 100 ft becoming from 0600 hrs to 0900 hrs visibility more than 10km few cloud at 4,800 ft'

1.7.4 Birmingham Airport

The TAF valid from 0100Z to 1000Z was as follows:

'Surface wind from 060/4kt, visibility more than 10km, few cloud at 4,800 ft PROB 30 TEMPO from 0400Z to 0800Z, visibility 8km, broken cloud at 800 ft'

The 0420Z METAR was:

'Surface wind calm, CAVOK, temperature 10C, dewpoint 8C QNH 1023 mb'

1.7.5 Liverpool Airport

The TAF valid from 0100Z to 1000Z was as follows:

Surface wind variable 5kt,, visibility more than 10km, few cloud at 3,000 ft, broken cloud at 4,800 ft TEMPO from 0100Z to 0800Z, visibility 7,000m

1.8 Aids to navigation

1.8.1 Stansted Airport

The ILS for Runway 05 at Stansted Airport had been withdrawn from service as a result of maintenance work in progress but a replacement instrument approach procedure had been established. This was a Temporary Surveillance Radar Approach (SRA) which was based on an existing SRA procedure. The minima for the Temporary SRA for this aircraft were a MDH of 930 ft and a RVR of 2,000 m.

1.8.2 Nottingham East Midlands Airport

The approach charts carried by the aircraft for this airport were filed under the title Nottingham East Midlands. The airport has a Category IIIB ILS approach installation for Runway 27; the ILS glidepath angle is set at 3°.

1.8.3 Birmingham International Airport

Birmingham Airport has CAT III ILS approach installations for both Runway 15 and Runway 33. Some time before the accident, Runway 15 ILS had been released for routine annual maintenance and, for this activity, the glideslope was turned off while the localiser continued to radiate. On completion of the work, the localiser was returned to service and the ILS was then switched for Runway 33 operations, but no post-maintenance switching check was carried out on Runway 15 ILS. Following the emergency landing, an inspection discovered that the glideslope for Runway 15 had not been reinstated following the maintenance work.

1.9 Communications

1.9.1 General

Recordings of the transmissions between the aircraft and each ATC unit in the UK were available for the investigation. Extracts from these communications have been included, where relevant, in the text of this report.

1.9.2 Nottingham East Midlands Airport ATC

At 0123 hrs on 15 June 2006, Ground Movement Control at EMA closed down and thereafter, the only ATC personnel on duty included the Watch Manager, three other controllers and two assistants.

At the time of the incident, the Tower Controller (ADI) and his assistant were located in the visual room of the control tower and the Watch Supervisor was in the Approach room, acting as the Approach Controller (APS), together with another assistant. Two other controllers were in the rest area.

1.9.2.1 Background

At 0404 hrs, the assistant in the 'Approach' room was informed by Essex Radar that there was a possibility of an aircraft, Quality 325N, diverting to EMA from its present position in a holding pattern at Stansted. Shortly after, the Watch Supervisor decided to change operations to Runway 27, which would enable

CAT III operations to be carried out. By 0418 hrs, the appropriate checks had been completed and Low Visibility Procedures (LVPs) were instituted on Runway 27.

At 0420 hrs, the Approach room assistant was asked by Essex Radar if Quality 325N would be able to use Runway 27; he advised that Runway 27 was now the operating runway and that LVPs were in force. The controllers in Approach and Tower were advised of the diversion possibility. At 0424 hrs, the assistant was informed that Quality 325N was indeed diverting to EMA with an estimated arrival time of 0432 hrs.

1.9.2.2 Accident

The acceptance of the aircraft by the APS and onward transfer to the ADI were uneventful. By 0437 hrs, the ADI had cleared Quality 325N to land on Runway 27 and this clearance had been correctly acknowledged by the crew. At 0438 hrs, the crew asked for, and were given, confirmation of the clearance to land.

However, at about this time a telephone message from the aircraft company's representative at EMA was received in the Tower. The message was responded to by the ADI, who was asked if Quality 325N would be able to land. He was informed that the company would like the aircraft to divert to Liverpool Airport rather than land at EMA. With the aircraft on final approach, the controller immediately took the decision to advise the crew of their company's request, and give them the opportunity to go around. However, when the commander asked for confirmation that the message was for his aircraft, the controller immediately responded with a clearance to land. Then, when he heard the sound of the aircraft going around, he thought that it may have been in response to his earlier transmission and asked the crew for the reason. At 0442 hrs, the crew informed the controller that the aircraft had touched the ground and asked him to standby. A short time later, the crew requested a diversion to Liverpool and this appeared to the controller as confirmation that they had gone around in compliance with the request from their company. He then transmitted initial instructions while he co-ordinated the diversion.

However, the APS, who was also the Watch Supervisor, had monitored the call from the aircraft about touching the ground and the request to standby. He was concerned that the call to standby referred to an emergency situation, rather than asking the controller to wait for more information, and immediately expressed his concerns to the ADI. Shortly thereafter, the crew declared a 'MAYDAY' and the APS instructed the ADI to transfer the aircraft to his frequency. By 0444 hrs, the crew had re-established contact with the APS on the approach frequency.

Over the next few minutes, the APS established the extent of the emergency and had co-ordinated the diversion to the nearest most suitable airport, Birmingham. At 0447 hrs, the controller transferred Quality 325N to Birmingham Radar on frequency 118.05 MHz.

1.9.2.3 Post-accident - Nottingham East Midlands Airport

As a result of the report from the flight crew that the aircraft had touched the ground, a runway inspection was carried out; this confirmed that the runway was clear of any debris. However, later on, the crew of an aircraft taxiing out for departure reported to ATC that there appeared to be a landing gear leg on the grass area between the runway and taxiway. A subsequent check revealed that it was the right main landing gear from OO-TND.

1.9.3 Birmingham ATC

OO-TND was handed over to Birmingham ATC at 0447 hrs. Initially, the aircraft was positioned for an approach to Runway 15, but when it became evident that the glideslope was not available on this runway, a change to Runway 33 was offered and accepted. The crew notified ATC that some dangerous goods were being carried on the aircraft. Then, an inspection by a police helicopter operating in the area was offered by ATC and accepted by the commander. The aircraft was routed to the west of the airport, where the helicopter was operating, and information about the status of the landing gear of the aircraft was obtained. Only one other aircraft was operating on the approach frequency; communications between ATC and Quality 325N were clear and uninterrupted.

1.10 Aerodrome information

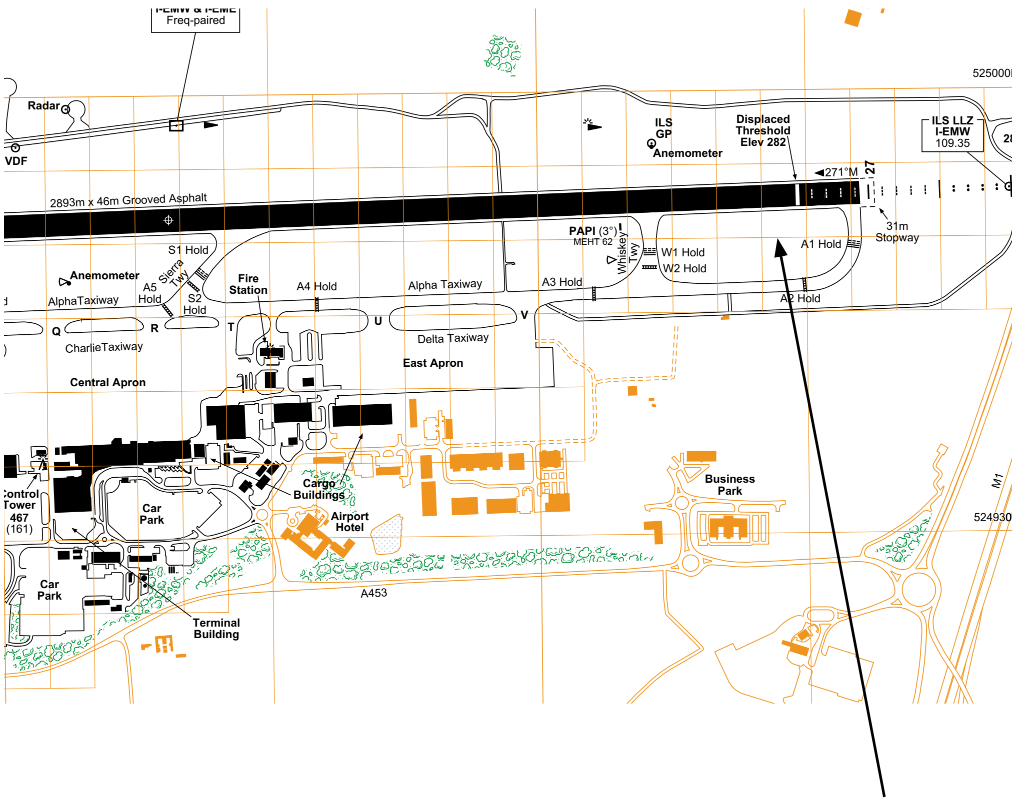
1.10.1 London Stansted Airport

London Stansted Airport was undergoing a programme of major runway maintenance; the work was taking place in several phases and Phase 1 was in progress at the time the aircraft was scheduled to arrive. During Phase 1, Runway 05 had a displaced landing threshold, giving a reduced LDA of 1,900 m, and an increased nominal glidepath angle of 3.5º, with temporary PAPIs.

1.10.2 Nottingham East Midlands Airport

Early in 2004 the name of East Midlands Airport was changed to Nottingham East Midlands Airport. After the date of the accident, on 8 December 2006, the airport operator announced another change of name, this time to East Midlands Airport – Nottingham, Leicester and Derby.

EMA has a single bi-directional runway with a grooved asphalt surface, designated Runway 09/27. Runway 27 is equipped with an ILS with CAT IIIB capability. A valley beneath the approach to Runway 27 means that a difference occurs between the pressure altimeter and the Radio Altimeter readings during the latter stages of an approach. The eastern end of Runway 27 in shown in Figure 5.



OO-TND ground contact area

Figure 5

Layout of the eastern end of Nottingham East Midlands Airport

1.10.3 Birmingham Airport

Birmingham Airport has a single bi-directional runway with a grooved asphalt surface, designated Runway 15/33. Runways 15 and 33 are both equipped with an ILS. Runway 33 is 2,605 m in length, 46 m wide and the threshold elevation is 325 ft amsl. The LDA is 2,304 m and PAPIs are located to the left side of the touchdown zone and are set for a 3° glideslope. The aerodrome category for fire-fighting is RFF Category 9[9].

1.11 Flight Recorders

1.11.1 General

The aircraft was fitted with a solid-state Cockpit Voice Recorder (CVR)[10] of 30 minutes duration, and a 25-hour duration solid-state Flight Data Recorder (FDR)[11], both of which were successfully downloaded by the AAIB. The EGPWS computer was also downloaded and its event history obtained.

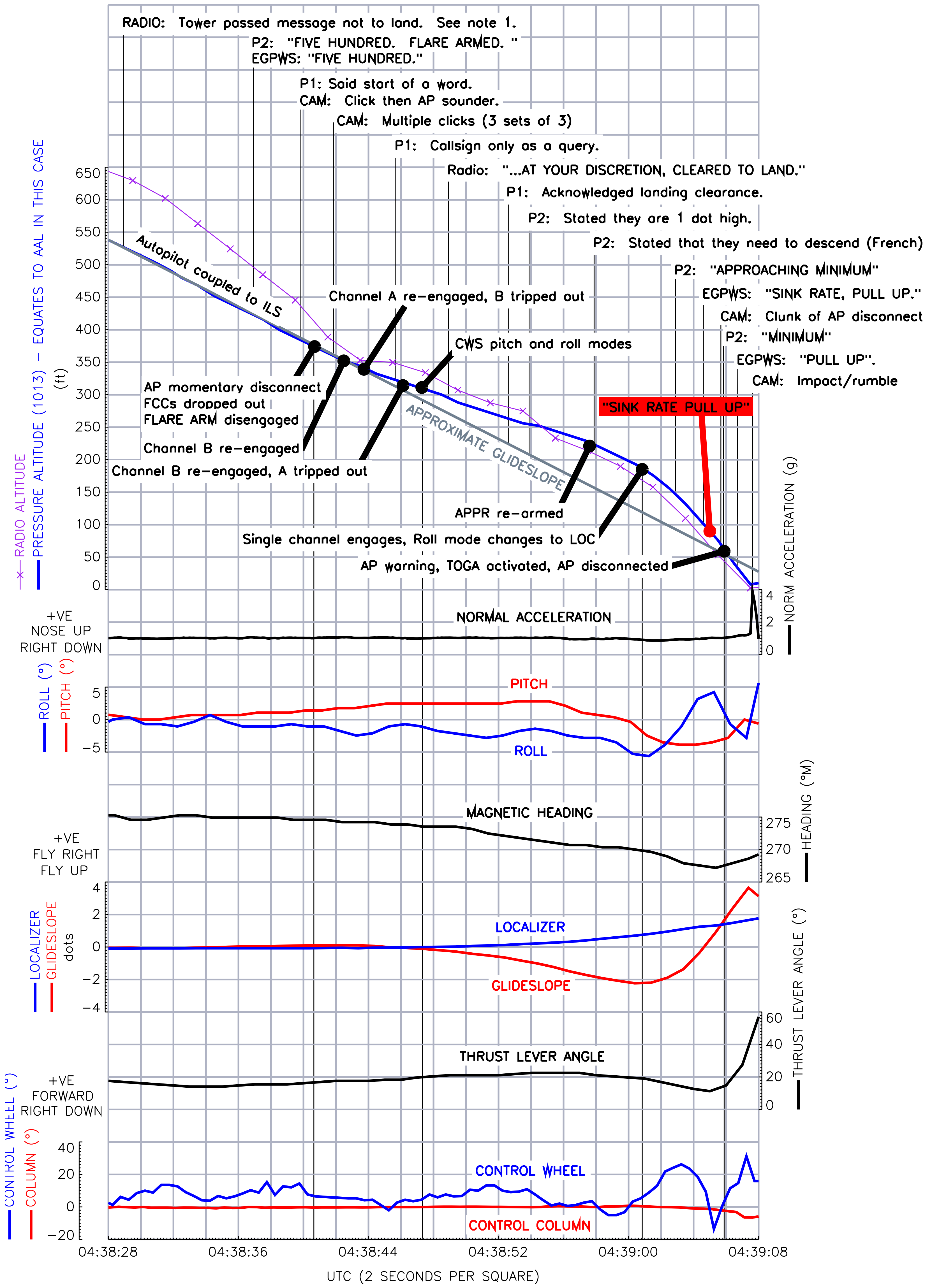
1.11.2 Flight history

The recordings from the CVR, FDR and EGPWS have been amalgamated to present the information in a chronological order. Figure 6 provides an overview of the whole flight.

The aircraft had taken off from Liège at 0312 hrs, climbed to FL240 and subsequently descended for arrival at Stansted. It entered the hold at Stansted at 6,000 ft and remained there until approximately 0420 hrs. After a short transit at FL100, the aircraft started its descent into EMA and, for the approach, the autopilot was coupled to the glideslope and localizer; both channels had engaged by approximately 2,000 ft amsl. The autothrust was engaged in MCP speed mode. By the time the aircraft had descended through 1,300 ft aal, the trailing edge flaps were fully down, the leading edge slats were fully extended and the landing gear was down.

At approximately 640 ft RA, corresponding to approximately 530 ft aal, a message from the ATC tower controller was transmitted, see note 1, Plot 1, but there was no immediate response from the crew. As the aircraft passed through 500 ft RA, the co-pilot called out "FIVE HUNDRED, FLARE ARMED" at the same time as the EGPWS generated its "FIVE HUNDRED" automatic callout.

9 RFF Category 9 is defined in the CAA Civil Aeronautical Publication 168, Table 8.1, and relates the extent of the equipment and personnel to be provided to the maximum size of aircraft allowed to use an airport.
10 L3 A100S CVR, part number S100-0080-00.
11 Honeywell SSUFDR, part number 980-4120-RXUS.



NOTES

1. The complete message was "THREE TWO FIVE NOVEMBER I'VE BEEN INSTRUCTED THAT YOU ARE NOT TO LAND HERE FROM YOUR OPERATION OP–OPERATIONAL AUTHORITY AT YOUR DISCRETION YOU MAY GO ROUND".
2. Throughout this period the gear was down and the flaps and slats were fully deployed.
3. Acronyms: AP – Auto Pilot, CAM – Cockpit Area Microphone, CWS – Control Wheel Steering, EGPWS – Enhanced Ground Proximity Warning System, FCC – Flight Control Computer, ILS – Instrument Landing System, LOC – Localizer, P1 – Commander, P2 – Co–pilot, TOGA – Take Off Go Around.

CVR and FDR recordings of the final approach into Nottingham East Midlands Airport

Plot 1

Approach to Runway 23 at Nottingham East Midlands Airport

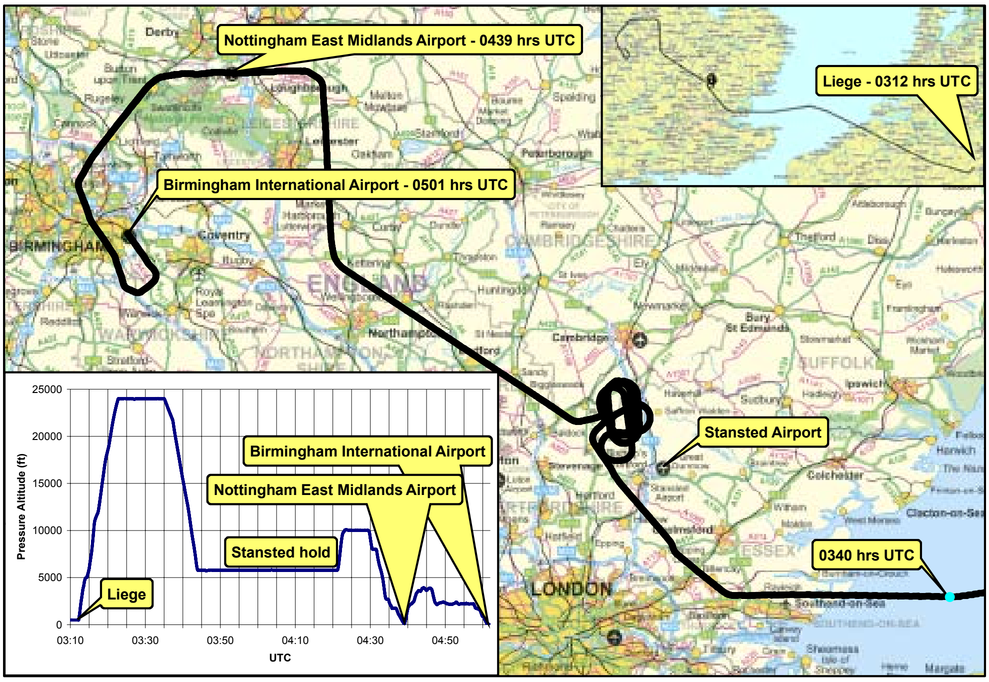


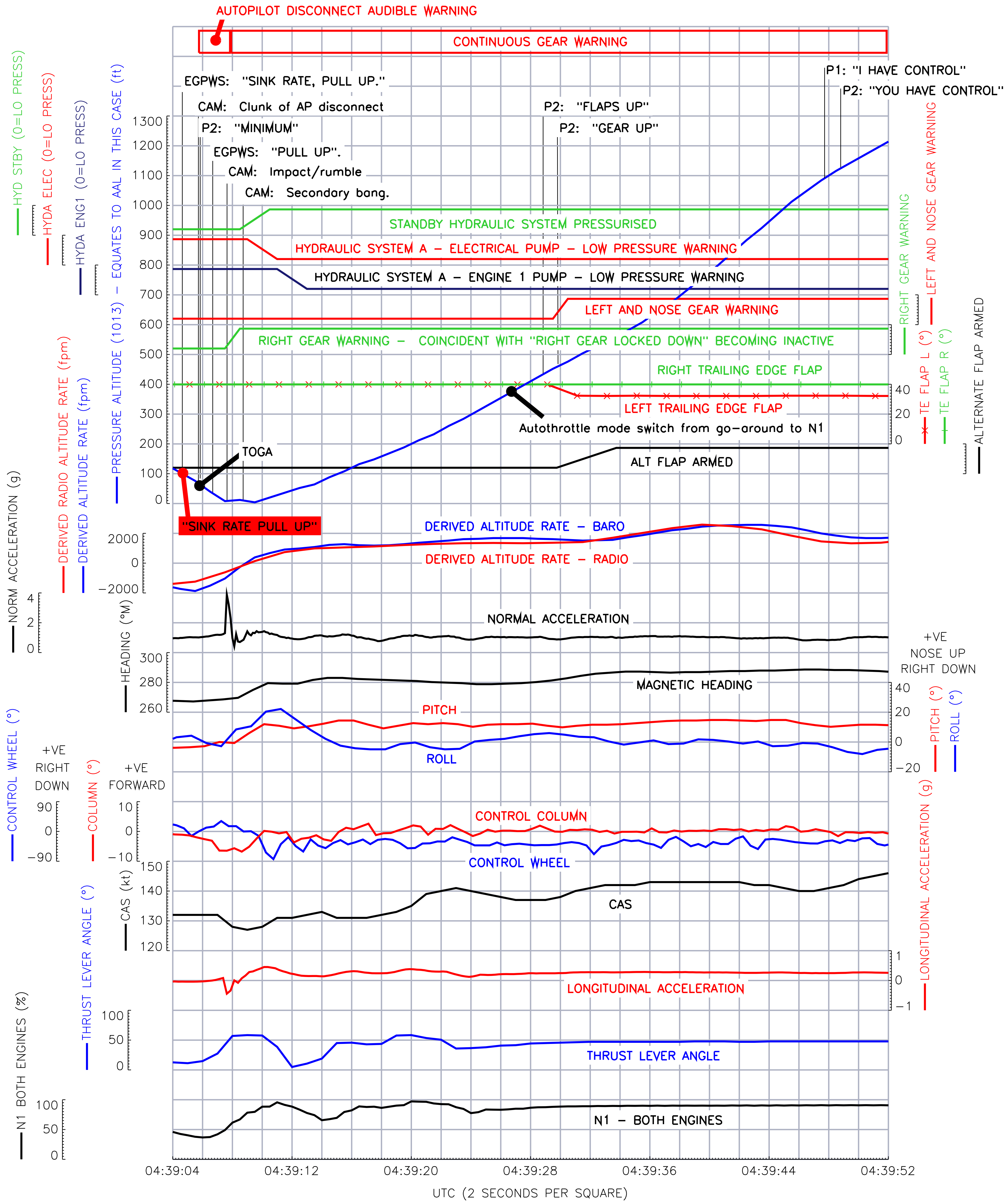
Figure 6

Overview of the flight from Liège, to Birmingham via EMA

On passing 380 ft aal, the commander started saying a word, but cut this short. At the same time, the CVR recorded a 'clunk' sound and the FDR recorded that both autopilot Channels A and B had disconnected.

A short time later, Channel B was re-engaged in Command mode. Channel A was then re-engaged, but this resulted in Channel B dropping out. When Channel B was re-engaged, Channel A dropped out. For most of the remainder of the approach, the autopilot was left with Channel B engaged and CWS P (pitch) and CWS R (roll) modes were active. At this point, the aircraft pitch trim had been adjusted by the autopilot and the aircraft's pitch attitude had become slightly more nose high than during the earlier part of the approach. The aircraft also adopted a slight left wing down roll attitude, with its heading diverging slowly to the left, towards the runway extended centreline.

Subsequently, the control column remained in a neutral position and the pitch attitude of the aircraft stabilised. The control wheel input was predominantly to the right, with an average deflection in the order of 10º. No parameters were recorded to indicate whether control forces were being applied by the crew, so it could not be determined directly whether subsequent changes in control wheel or column position were due to crew or autopilot inputs.



NOTES

1. The only CVR extracts that are relevant to the presented data are given here.
2. Throughout this period the lateral acceleration did not exceed 0.2g, there were no autothrottle warnings, no brake action, thrust reverser action, stick shake , engine assymetry or engine vibration was recorded. The nose and left gear remain down. The autopilot remained disengaged after it tripped out prior to the impact.
3. Acronyms: AP – Auto Pilot, CAM – Cockpit Area Microphone, EGPWS – Enhanced Ground Proximity Warning System, P1 – Commander, P2 – Co-pilot, TOGA – Take Off Go Around.

CVR and FDR recordings of the impact and go-around at Nottingham East Midlands Airport

Plot 2

Departure from Nottingham East Midlands Airport

Prior to re-engaging Channel B for the final time, the commander made a transmission, stating the aircraft call sign but in the manner of a question, "TALKING TO THREE TWO FIVE NOVEMBER?" After Channel B had been re-engaged, the controller confirmed that the aircraft was cleared to land; by this time the aircraft had descended through 300 ft aal.

At 250 ft aal, the co-pilot stated that they were 'ONE DOT HIGH'. The control column then went slightly forward and the pitch attitude of the aircraft started to decrease. Shortly afterwards, the approach mode was re-armed; this was done as the co-pilot expressed in French 'we need to descend'. The control column then moved further forward, pitching the aircraft nose down at a rate of 2º/sec. It was then brought back, such that the aircraft's pitch attitude stopped at 4º nose-down. The co-pilot then gave the "APPROACHING MINIMUMS" callout but, by this time, the aircraft was 130 ft aal, 1.5 dots above the glideslope and descending at an increasing rate of descent of more than 1,500 fpm. At an RA of between 87 ft and 59 ft an EGPWS "SINK RATE PULL UP" warning was recorded.

Almost immediately, the autopilot and autothrust modes went to TOGA mode. Between 1.5 and 2.5 seconds before impact, the autothrust dropped out of MCP speed mode and entered GA mode. As TOGA mode was activated, the control column was brought back, the pitch of the aircraft increased, the wings levelled and the audible autopilot disconnect warning was triggered. After the autopilot was disengaged for the go-around, it was not re-engaged for the rest of the flight.

Plot 2 covers the period of the impact with the ground and subsequent go-around.

The aircraft's descent rate just prior to impact was in the order of 1,500 fpm and the maximum recorded normal acceleration during the impact was 3.9g. There were two data samples, a quarter of a second apart, of longitudinal retardation, of 0.44g and 0.34g, followed by a sample of neutral acceleration. A further sample of retardation was followed by a rising forward acceleration. This resulted in a reduction in recorded CAS from 132 kt to 127 kt. The impact was clearly audible on the CVR, followed by a rumbling noise and a further impact sound, one second after the initial impact sound. The sample rates of the pitch and roll parameters were too low to determine the aircraft's precise attitude on impact, but it was not far from level in both pitch and roll. The thrust levers had not quite attained their full forward movement at that time. The aircraft struck the ground at 0439 hrs.

During the impact sequence, the right main landing gear warning parameter on the FDR became active and the landing gear warning sounded, remaining on for the rest of the flight. Over this period, the thrust levers completed their forward movement but started to retard within 2.5 seconds of the initial impact, as the aircraft began to climb, moving back over the next two seconds before advancing again. Throughout this period, the aircraft's climb rate continued to increase, initially dwelling at 1,200 fpm before increasing to more than 1,500 fpm. The engine vibration parameters showed no significant changes, post-impact, and the autopilot and autothrust warning parameters remained inactive throughout the remainder of the flight.

Within five seconds of ground contact, hydraulic System A 'Electrical Low Pressure' and 'Engine 1 Low Pressure' warning parameters were triggered and the Standby hydraulic system low pressure parameter became inactive, indicating that the standby system had pressurised.

As the aircraft climbed through 350 ft aal, the autothrust mode changed from 'go-around' to 'N_1'. Twenty two seconds after the impact, just after a "GEAR UP" call, the left main and nose landing gear warnings activated. At the same time, the left wing trailing edge flap angle moved to 32º, but the right trailing edge flap angle remained at 40º. This was shortly followed by the arming of the Alternate Flap system. However, the trailing edge flaps, together with the fully deployed leading edge flaps and slats, did not alter their positions for the remainder of the flight.

For 20 seconds after the impact, the only verbal communication that was operationally appropriate came from the co-pilot[12]; 40 seconds after the impact, the commander stated "I HAVE CONTROL", the co-pilot replied with "YOU HAVE CONTROL". The audio recordings indicate that the commander remained the PF for the rest of the flight. The crew communicated their status to ATC and, as Birmingham International Airport had clear weather, it was selected as the destination. The aircraft was ultimately vectored for an ILS approach to Runway 33.

The aircraft landed at Birmingham International Airport at 0501 hrs, 22 minutes after striking the ground at EMA. Thrust reversers were used after touchdown but the inboard thrust reverser of the right engine failed to unlock and deploy, and the outboard thrust reverser of the left engine deployed approximately 15 seconds after its inboard thrust reverser. Initial deployment coincided with

12 Without image recording in the cockpit, any non-verbal communication that may have occurred could not be identified.

a brief low pressure warning for the Standby hydraulic system. The stick shaker activated during the ground roll some time after the thrust reversers deployed.

From EMA to Birmingham Airport, the average rate of fuel consumption was approximately 4,000 kg/h, almost twice as much as that recorded whilst in the hold at Stansted. The aircraft systems recorded that there was just under 2,000 kg of fuel remaining after landing at Birmingham.

1.12 Accident sites and aircraft examination

The accident occurred at EMA, with the subsequent emergency landing being made at Birmingham Airport. Both sites are described below.

1.12.1 Nottingham East Midlands Airport

The first ground marks made by the aircraft were identified as being from the left and right main landing gear wheels, Figure 7. These were some 90 m to the left of the centreline of Runway 27 in the graded and sterile area, 89 m beyond taxiway Alpha 1. The marks indicated that the aircraft initially touched down in a near wings level attitude. The wheel tracks continued on the grass in a direction of 262°M for approximately 13 m, after which the main wheels began to sink into the ground to a depth of approximately 25 cm. As they did so, the nosewheel made contact with, and remained on the ground for 58 m.

The main landing gear wheel furrows continued for 5.5 m, at which point the left main landing gear wheels appeared to have lifted up and run along the surface for a further 14 m. The right main landing gear tracks stopped at the end of the wheel furrows, indicating the most likely point at which the leg separated from the aircraft. Debris was found in the area immediately beyond these furrows. This consisted of pieces of landing gear door, cables, hydraulic lines from the landing gear leg, and the right main landing gear up-lock actuator, Figure 8.

Two impact craters were evident which were consistent with having been made by the detached landing gear leg. The first crater was 57 m beyond the end of the furrows made by the right main landing gear wheels, the second 100 m beyond. The right main landing gear unit and the landing gear retraction actuator were found 190 m beyond the point of separation, and 36 m from the left shoulder of Runway 27.

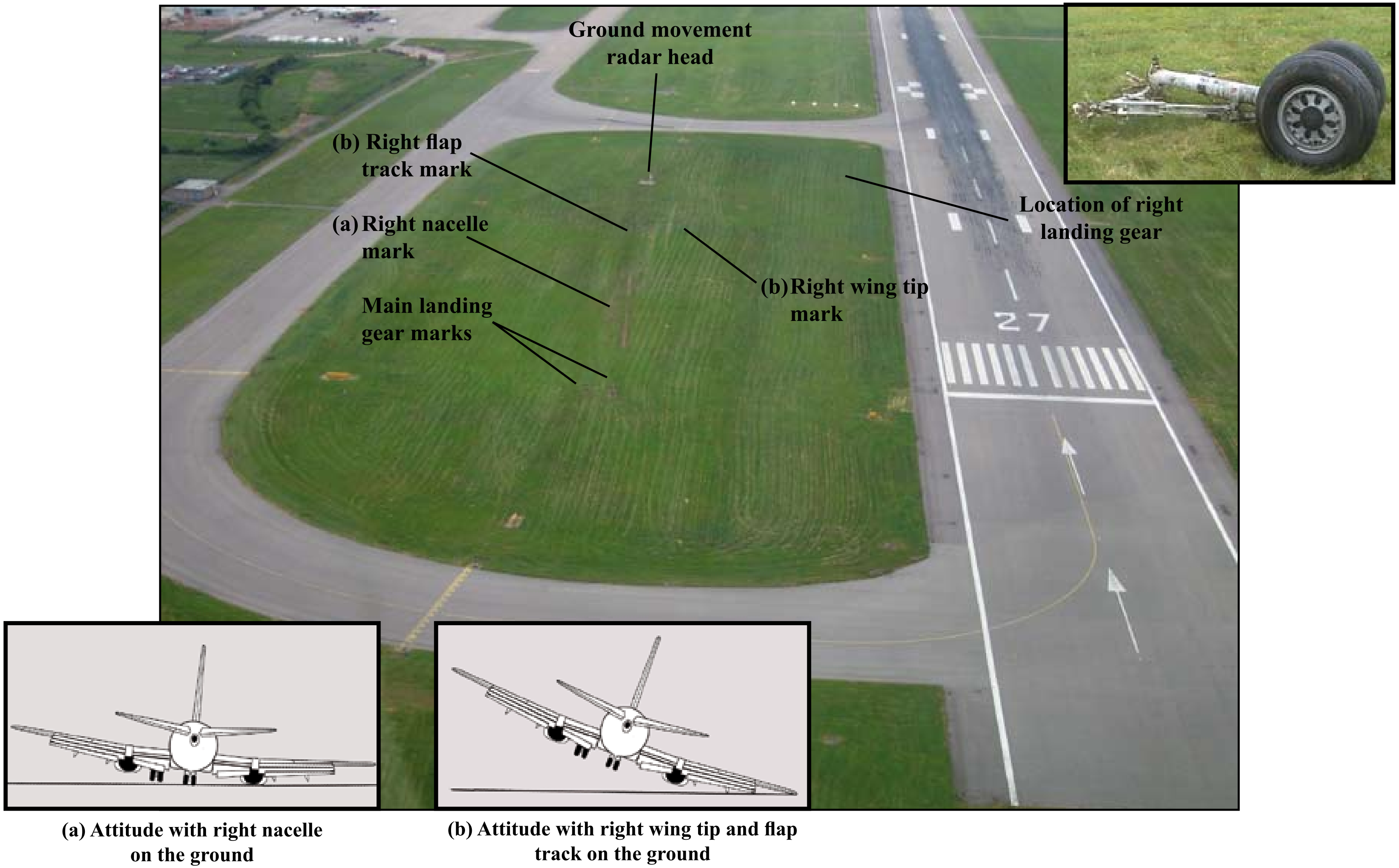


Figure 7

Ground marks made by OO-TND at East Midlands Airport

Figure 8

OO-TND debris recovered at East Midlands Airport

Some 35 m beyond the end of the ground marks made by the right main landing gear, the right engine nacelle made contact with the ground and remained in contact for 45 m. Debris found along this ground mark consisted of pieces of nacelle and thrust reverser fairing.

Some 30 m beyond the start of the right engine nacelle ground mark, other marks were present, approximately 35 m in length, consistent with the right wing outboard flap track fairing having made contact with the ground. These marks showed that, at this point, the aircraft was veering onto a heading of 270º. A landing light, which is normally located in the right flap track fairing, was found embedded in this ground mark.

Approximately 20 m beyond the first mark made by the outboard flap track fairing, another ground mark was present. This was consistent with ground contact by the right wing tip over approximately 30 m and was the last ground mark made by the aircraft. Based on the measurements of these marks, the aircraft was banked approximately 13º to the right at this point and was tracking 270º, with the right wing outboard flap track fairing and wing tip in contact with the ground.

Pieces of turf were found on and around the ground radar head. It was estimated that the aircraft came within 10m of this obstruction.

1.12.2 Birmingham International Airport

After touching down, the aircraft came to rest on the runway centreline, 30 m beyond the touchdown zone markings for Runway 15. The left main landing gear and nose gear legs were fully extended and were locked in the down position. The aircraft was supported by its right engine nacelle, both left main wheels and the right nosewheel; the left nosewheel was just clear of the runway surface.

There was no evidence that any fuel had leaked from the aircraft.

1.12.3 Aircraft examination

Grass was present in the structure of the right wing tip, both flap track fairings of the right wing outboard flap, the underside of the right engine nacelle, and both the nose and left landing gear legs. A review of the Police Air Support Unit video of the landing at Birmingham, as well as the marks made on the runway at Birmingham, confirmed these grass deposits were not made during the landing at Birmingham and therefore resulted from contact with the ground at EMA.

Structural damage had occurred to the right inboard trailing edge flap, and further damage and tyre marks were present on the side of the fuselage, aft of the right wing. This was consistent with the right landing gear leg having struck the fuselage after becoming detached. At their highest point, these marks were close to the line of blanked out windows, Figure 9, and it was apparent that the departed leg had come close to striking the horizontal stabiliser.

A continuous 75 cm wide mark was present on the runway, apart from one gap where the nacelle had not made contact with the runway during the landing roll, which extended from the touchdown zone marking for Runway 33 to the right engine nacelle of the stationary aircraft. This ground mark was approximately 5 m to the right of the centreline of the runway over its entire length.

The fuel remaining on the aircraft after it landed at Birmingham was determined as follows:

Figure 9

Details of flap damage and tyre marks on rear fuselage

Left wing tank	941 kg
Right wing tank	996 kg
Centre tank	zero (not used)

The wing tank values were established from 'dripstick' readings, at five locations on each wing, and converted into kilograms using the appropriate Boeing document.

After the accident, the cargo on board the aircraft was weighed as it was removed and found to conform to the load manifest in terms of weight and distribution. No rupture or disruption of any of the packaging, and no substantial movement of the load, had occurred as a result of the accident.

The right main gear leg was retrieved from EMA and examined in relation to the aircraft. The leg had become detached from the wing structure at four locations. The two structural fuse pins in the forward and aft trunion bearings had both failed, leaving the wing/fuel tank structure intact. The other two locations were the uplock support structure and the walking beam hanger structure. The main gear actuator and the walking beam had also failed, resulting in the gear leg assembly breaking into two distinct parts.

The upper link, diagonal brace and the mid-spar attachment fuse pins, six in total, were removed from the right engine pylon. No deformation had occurred to these pins.

1.13 Medical and pathological information

None.

1.14 Fire

There was no fire, although some smoke was seen around the aircraft at the end of the landing run at Birmingham. Airport Fire and Rescue Service vehicles had been pre-positioned close to the runway, both behind and ahead of where the aircraft came to rest. This enabled the first vehicle to reach the aircraft within 15 seconds. As a precaution against the possibility of fire, a foam blanket was applied to the ground and the right side of the aircraft.

1.15 Survival aspects

None.

1.16 Tests and research

1.16.1 Nottingham East Midlands Airport ILS system check

The ILS for Runway 27 had been flight checked on 6 January 2006, and assessed as fully serviceable. Additionally, the system was ground checked at 0730 hrs on the day of the accident, and all parameters were within the required limits.

1.16.2 Aircraft ILS system check

The ILS system in the aircraft was tested shortly after the accident, using appropriate ground test equipment, and was found to operate satisfactorily.

1.16.3 Air speed indicator (ASI) system and altimeter check

A calibrated air data test set was used to test the ASI and altimeter systems over a range of speeds and altitudes that covered those recorded throughout the flight. The left, right and standby air speed indicators gave readings within 1 kt of the test equipment; the readings for the left and right altimeters were within 35 ft of the test equipment.

1.17 Organisational and management information

1.17.1 Operator

The airline holds an Air Operator's Certificate (AOC), issued by the Belgian Civil Aviation Authority, and operates a mixed fleet of aircraft on scheduled and ad hoc cargo services on international routes. All flights are operated in accordance with the requirements of JAR-OPS 1 and the operator holds an approval to conduct low visibility procedures in the B737 aircraft. Operating procedures and information for pilots is provided in the Operations Manual (OM), including the Standard Operating Procedures (SOPs). There are specific procedures for Category II/III approaches.

The operator advised that their SOPs do not permit a co-pilot to call STOP in the event of a problem arising on takeoff; the co-pilot should advise the commander of the nature of the problem and he would make the decision to go or stop. Co-pilots are expected to call GO AROUND and be proactive should a problem occur during an approach although this was not specifically stated in the OM.

1.17.2 Category II/III approach crew training and recency requirements.

The operator conducts initial and recurrent training of their flight crews in low visibility operations (LVOs). The requirements for crew qualification for low visibility procedures are laid out in JAR-OPS 1. The section dealing with validation states:

> *'The required number of approaches within the validity period of the operator proficiency check (as prescribed in JAR-OPS 1.965(b)) is to be a minimum of three, one of which may be substituted by an approach and landing in the aeroplane using approved Category II or III procedures.'*

The OM reflected this training requirement. The procedures for conducting LVO approaches were precise and were laid down in the OM. (See 1.17.3)

LVO training is normally achieved by carrying out a number of approaches in a simulator followed by one or more practice approaches in an aircraft. Failures can be introduced by an instructor during simulator approaches which require a decision to be made by the crew as to whether to continue the approach or to carry out a missed approach, according to the required procedures. Many failures are practised during training with the aim that pilots will have experienced most possible failures once, and therefore should be prepared if they should encounter them again.

1.17.3 Category II/III procedures

The OM contains a section dedicated to All Weather Operations. For CAT II/III approaches, the commander is always designated as the pilot flying (PF). Standard actions and calls are required for CAT II/IIIA approaches and these are stated in the OM and summarised in the table below.

Condition	CPT	F/O
500 ft above TDZ	**"Checked"**	**"500 flare armed" or "No flare"**
100 ft to DH	**"Checked"**	**"Approaching minimums"**
DH/RA	**"Landing or GO-Around"**	**"Minimums"**
At 30 ft RA	**"Checked"**	**"Flare"** or **"No Flare"**
Until 60 kts		Call out any malfunction

Table 1

CAT II/IIIA SOP calls and actions

The following guidance for CAT II/III approaches is also included in the All Weather Operations section:

> *'The captain should give a thorough briefing of the planned approach. Special emphasis should be placed on the fact that the crew must be springloaded to go-around at the first sign of an abnormal situation.*
>
> *A Category II/III approach cannot be commenced or continued under pressure or with any single point of doubt with respect to aircraft position or status. If either crew member feels uncomfortable during the approach he/she should state so and a go-around should be initiated promptly.'*

There is a further statement at the end of the section:

> *'Any failure below 1,000 ft AGL implies a go-around.'*

1.17.4 Provision of meteorological information

1.17.4.1 General

Civil Aviation Publication (CAP)746 contains procedures and information which describe the provision of meteorological observations to civil aviation in the UK, and the related regulatory requirements.

1.17.4.2 Automatic Terminal Information Service (ATIS)

Air Traffic Service (ATS) standards and procedures for the issuance of ATIS information are contained in CAP 670 and the Manual of Air Traffic Services (MATS) Part 1.

The meteorological data for the ATIS may be automatically sensed and compiled or alternatively may be extracted from the local meteorological routine or special report. It is the responsibility of the ATS provider to ensure that the accuracy and integrity of the data used in the preparation of the ATIS message is maintained at a level appropriate to the operational requirements.

1.17.4.3 METAR and TAF

It is the responsibility of the ATS provider at an aerodrome to observe the meteorological conditions and compile the METARs; these are then forwarded to NATS for general distribution. The UK Met Office also receives the METARs and uses them as one source of information about actual conditions. This aerodrome-specific information is incorporated into TAFs, which are then forwarded to NATS for distribution.

The runway visual range (RVR) group is reported in the METAR only when either the minimum visibility or the RVR at the touchdown end of the runway is observed to be less than 1,500 m at any point. A Special Report (SPECI) should be issued when the prevailing visibility changes from one defined range to another as follows:

10 km or more, 5,000 m to 9 km, 3,000 m to 4,900 m, 2,000 m to 2,900 m, 1,500 m to 1,900 m, 800 m to 1,400 m, 750 m or less

1.17.5 ATC provision of information to flights

At the time of the accident, MATS Part 1 contained no restriction on ATC controllers passing information to aircraft at any time in flight, as long as it is pertinent to the flight. Guidance for controllers regarding the passing of operating company messages to aircraft was included, as follows:

> *'When requested by a company representative, controllers may transmit specific operational messages to aircraft subject to normal air traffic service requirements and shall prefix the transmission 'Company advise/request………'*

A related amendment was being produced at the time of the accident, and became effective on 31 July 2006. This amplified the above paragraph to the following:

> *'When requested by a company representative, controllers may transmit specific operational messages to aircraft subject to normal air traffic service requirements and shall prefix the transmission 'Company advise/request……'. When passing such messages the controller must ensure that doing so will not compromise the safe provision of an air traffic service and such messages should not be passed when they could act as distraction to pilots during critical phases of flight.'*

1.18 Additional information

1.18.1 Pilots' recollections - general

The pilots were interviewed within a few hours of the event and again some weeks later and both supplied information regarding their recollections of events. In most respects their recollections were similar, although there were understandable differences with reference to the latter stages of the approach and the go-around at EMA. Neither pilot had any idea of where the aircraft contacted the ground during the approach to EMA. The information received from both pilots has been incorporated within the *'History of the flight'* section of this report.

1.18.2 Commander's recollections

The commander reported that the approach to EMA had been normal until, between 1,000 ft and 500 ft aal, he heard a radio call from ATC. He thought the call might have been for his aircraft and that it was instructing him not to land. Unsure of what he had heard, and uncertain as to whether the aircraft was still cleared to land, he waited a moment for the SOP '500 ft' call. He then sought clarification from ATC but, in attempting to transmit his message, he pressed the autopilot disconnect button by mistake. Confused by what happened, and still thinking about the ATC transmission, he reselected the autopilot. He then transmitted a response to ATC [TALKING TO THREE TWO FIVE NOVEMBER], following which the controller confirmed that the aircraft was cleared to land. He next saw 'green' ahead through the windscreen and heard the EGPWS PULL UP warning. He pulled up and initiated a go-around but, as he did so, the aircraft contacted the ground. He heard the co-pilot call out "go-around" several times, applied power and, in his own words, "recovered his senses".

1.18.3 Co-pilot's recollections

The co-pilot reported that, on the approach into EMA, all had been normal until after the '500 ft' call. He made the SOP call "five hundred feet flare armed" and heard the autocall as well. He was aware there had been a radio call from ATC, but did not understand it. He then heard the autopilot disconnect warning and saw the flight director disappear. After checking his flight instruments and the autopilot status, which had changed to CWS P and CWS R, he intended to announce the change but, before he did so, the commander re-engaged an autopilot. He continued to monitor the instruments and saw VOR/LOC in green (engaged) and G/S in white (armed) on the FMA. He also saw the glideslope pointer moving rapidly and called out 'ONE DOT HIGH' and sought to confirm that the commander understood this. He then saw his own VSI showing a descent of 1,000 fpm; during this time, he was expecting the commander to initiate a go-around. He then heard the EGPWS warning, after which the commander did initiate the go-around. However, after the aircraft contacted the ground, he thought that the commander was not reacting, and so shouted out 'GO-AROUND' several times. He assisted with applying thrust and pulled the control column back to get the aircraft airborne and into a stabilised climb.

2 Analysis

2.1 General

For a short period during the approach into EMA, the commander lost situational awareness, following inadvertant disconnection of the autopilots, and allowed the aircraft to descend to an uncontrolled contact with the ground. The analysis of the ground marks to the left of Runway 27 threshold, in conjunction with the damage to the right wing tip, indicated that the aircraft had been close to entering an uncontrollable situation as it slid over the ground, from which it would almost certainly not have recovered. The detached right main landing gear had struck the right inner flaps, the rear fuselage - narrowly missing the horizontal stabiliser - and the aircraft passed very close to the surface movement radar head. It is therefore apparent that a catastrophic accident was narrowly avoided.

Although the damage sustained by the aircraft resulted in some handling difficulties, it did not prevent the pilots from being able to regain control. Fortunately, the engines continued to operate normally, which enabled the aircraft to takeoff, climb and continue in flight to Birmingham, where a successful emergency landing was made.

2.2 Engineering analysis

2.2.1 Aircraft examination - general

Although damaged, OO-TND was relatively intact. This allowed a straightforward examination of the aircraft and its systems to be carried out, such that confidence could be placed in the findings.

2.2.1.1 ILS and ASI systems

Before the inadvertent disconnection of the autopilots, all information indicated that the aircraft's ILS and ASI systems were functioning normally. After the aircraft was recovered from the runway at Birmingham, these systems were tested using the appropriate test equipment, and found to operate satisfactorily. Therefore, the performance of the ILS and ASI systems in the aircraft is not considered to be a causal or contributory factor in the accident.

2.2.1.2 Hydraulic systems

From the FDR data it was determined that the hydraulic systems on the aircraft appeared to be operating normally until the aircraft struck the ground. Within a very short time of the right landing gear warning, which sounded during the aircraft's contact with the ground, the Standby hydraulic system pressurised and hydraulic System A became depressurised. The FDR/CVR data showed that after GEAR UP was called, the left and nose landing gear warnings were triggered, indicating that the gear lever had been selected to UP. This was consistent with detachment of the right landing gear, causing loss of the fluid in hydraulic System A downstream of the landing gear transfer valve, which precluded retraction of the nose and left landing gears.

As all damage and failures occurred after the aircraft contacted the ground, the performance of the aircraft's hydraulic systems is not considered to be a causal or contributory factor in the accident.

2.2.1.3 Structural fuse pins

The structural fuse pins which attached the right landing gear to the aircraft, failed as intended in the impact, ie, in preference to the wing structure, thereby maintaining the structural integrity of the wing. There were no fuel leaks from the wing and the aircraft remained controllable, albeit in a partially asymmetric full flap configuration. The asymmetry resulted from damage occasioned to the right flaps as the leg departed.

Although the right engine made contact with the ground at EMA over a distance of approximately 45 m whilst under high power, the ground scar was fairly light. This indicated that any abnormal loading applied by the engine/pylon to the wing was low and insufficient to cause any observable damage to the six fuse pins.

2.2.1.4 Autopilot

From the recorded data, both flight control computers were engaged and were tracking the localiser and glide slope normally during the initial part of the ILS approach into EMA. However, after the autopilots were inadvertently disconnected, attempts were made to re-engage both channels. As the aircraft was not in APP mode at this time, only one channel could be engaged, Channel B in this case. Without a mode selected, the autopilot defaulted to CWS P and CWS R modes, but with the heading and pitch holds active. When CWS R became active the aircraft's roll attitude was slightly left wing low. This was maintained for just over 10 seconds, during which period the heading slowly reduced, resulting in the aircraft deviating increasingly to the left of the runway extended centreline. This occurred before the APP mode was re-armed shortly before the aircraft struck the ground and, therefore, was most likely the result of a pilot input. After the APP mode became active, the aircraft re-acquired the localiser and began a gentle roll to the right.

At no time did the FDR record that the glideslope was re-captured by the autopilot or that there was any attempt by the aircraft to reduce its rate of descent as it approached the glideslope from above. It passed through the glideslope, at approximately 45 ft aal and with a rate of descent in excess of 1,500 fpm.

The recorded pitch and roll inputs made during the final stages were almost certainly made by the commander as the PF. The performance, therefore, of the flight control computers/autopilots is not considered to have been a causal or contributory factor in the accident.

2.2.1.5 Flaps

The recorded data indicated no abnormalities in the operation of the trailing edge flaps prior to the aircraft striking the ground.

After the call FLAPS UP in the go-around, the trailing edge flaps attempted to retract, as hydraulic System B remained pressurised. The left flaps moved to 32º but the right flaps remained at 40º, as a result of mechanical damage caused by impact from the right landing gear as it broke away from the aircraft. The Flap Asymmetry Detection System had operated and prevented further flap movement, thus minimising any subsequent control difficulties.

Approximately 20 seconds after the impact, the electrically powered Alternate Flap system was armed but this system provides no asymmetry protection. Arming the system enables the use of a control, separate from the normal flap lever, to drive the flaps up or down. No parameter relating to the operation of this control is recorded but, as there was no evidence of any electrical power failure in the recorded data, the lack of further flap movement would indicate that no attempt was made to operate the system. This is consistent with the commander's decision to make no attempt to 'clean up' the aircraft, preferring instead to keep the aircraft in a configuration that allowed sufficient control to be maintained, rather than risk a deterioration in its handling qualities.

2.2.2 Ground Equipment

After the accident, the ILS systems at EMA and Birmingham were checked by the airport authorities and found to be serviceable. Because of the omission to reinstate the ILS glideslope for Runway 15 at BHX following maintenance, the commander decided to use Runway 33. This resulted in a significant increase in the time and distance flown by the damaged aircraft before landing, and may have placed additional pressure on the flight crew.

2.2.3 Summary

In summary, the engineering investigation identified no pre-accident faults within the aircraft or the ILS equipment at EMA, and therefore concluded that technical issues were not causal or contributory factors in this accident.

2.3 Conduct of the flight

2.3.1 Arrival in the Stansted area

The pre-flight planning by the pilots was thorough and took into account the work in progress at London Stansted Airport and the weather forecasts for the southern UK. Extra contingency fuel was put on the aircraft once the final cargo load figures had been received but the possibility of fog or Category III weather conditions was not forecast and, therefore, not a consideration.

On arrival in the Stansted area, the commander realised that the weather conditions precluded making an immediate approach. The aircraft entered a holding pattern which was maintained for 25 minutes. During this time, the commander, who was the PF, made several attempts to contact his company in order to confirm that the preferred diversion airfield was EMA. He had thought initially that the weather might improve at Stansted. When it became apparent that it was getting worse rather than better, he made the decision, in good time, to divert. This ensured that several options remained available for the diversion. Although the weather was deteriorating at EMA, it was possible to carry out a Category IIIA approach there and, if unsuccessful, then sufficient fuel would remain to continue to Liverpool, where the weather was clear.

The commander, in discussion with the co-pilot, and taking into account the operator’s commercial preference, decided that this was the best course of action.

2.3.2 Diversion to Nottingham East Midlands Airport

The time from the initiation of the diversion from Stansted to the aircraft being established on the localiser at EMA, was 15 minutes. During this period the pilots were busy with planning for the approach. Finding the correct approach charts took some significant additional time because of the new airport name. Whilst some of the preparation could have been done beforehand when in the hold at Stansted, the final decision as to where the aircraft would be landing was not made until the time of diversion. This was due to the delay in confirming with the company that the preferred 'commercial' diversion airport was EMA.

The commander could have made more time to plan and prepare for the approach at EMA by entering a holding pattern, but then there would not have been sufficient fuel available to maintain the option of being able to divert to Liverpool. In the event, he carried out the approach briefing while en-route to EMA, noting that a Category IIIA approach might be required. Fog had not been forecast and, even though he had received information that it was developing, he probably still did not expect it to be really dense. It is possible, therefore, that he had still expected to see something of the runway environment whilst descending through the final few hundred feet of the approach.

2.3.3 Final approach to Nottingham East Midlands Airport

The approach into EMA was uneventful up to the point of the radio call made by ATC, concerning the 'company' message, when the aircraft was below 1,000 ft. The controller did not use the full call sign of the aircraft, only the flight number, 325N, and this may explain the commander's uncertainty about for whom the call was meant. However, he heard the message which included the words '….OPERATIONAL AUTHORITY…..' and '…..NOT TO LAND…..', and was worried that the aircraft might no longer be cleared to land. The co-pilot did not respond to the call, both because he had not realised it was addressed to his aircraft and because he had not comprehended the words. The commander, confused by the message and thinking it might be very important, tried to reply himself but inadvertently disconnected the autopilot instead of pressing the transmit button.[13] Although such an action is a simple, and fairly common, type of error his attempt to reply was a deviation from the company SOP and it was from this moment that he was no longer fully in control of the approach.

13 It should be noted that the heightened security environment of the last few years does create additional considerations for pilots. There may be circumstances in which an aircraft, for other than normal operational reasons, would not be permitted to land at an airport at short notice.

The commander recognised at once that he had used the wrong button on the control column and stopped speaking. The unexpected result of his attempted transmission appears to have distracted him further from his primary task of monitoring the approach, at a time when his attention was probably still focused, at least in part, on trying to understand what ATC had said. During this short period of distraction, while he was responding to ATC, he attempted to reinstate the autopilot. A natural and automatic human response to a problem, particularly when under stress, is to reverse actions associated with an unwanted effect, in an attempt to re-establish a status-quo. Thus, the commander's action of re-engaging the autopilot was probably an (inappropriate) automatic rather than a considered action.

The commander disconnected the autopilot when the aircraft was below 500 ft aal; this was the moment at which a go-around should have been initiated. The co-pilot, who was monitoring the approach, realised that the autopilot had disconnected but did not say 'GO-AROUND'. Had he done so, it is very likely that the commander would have overcome his own distractions and carried out a go-around in good time.

The reason for this is not clear but an indication may be found in the wording of the OM, as follows:

> *'If either crew member feels uncomfortable during the approach he/ she should state so and a go-around should be initiated promptly.'*

This would indicate that the co-pilot should have advised the commander of any deviation from the correct approach parameters, but it does not specifically state that the co-pilot should call for a go-around. He acknowledged, when asked, that he had expected the commander to initiate a go-around when the approach became unstable. He made several calls to alert the commander, with reference to the autopilot modes and to the deviation from the glideslope, but he was not clear that it was his duty to call 'GO-AROUND'. Conversely, the commander, who had until recently been a co-pilot in the company, had a clear expectation that, if the co-pilot had recognised a problem, then he should have made the call.

The operator has advised that co-pilots are expected to call for a go-around when required and, therefore, it would seem that the co-pilot's training, or recurrent training, had been ineffective in this respect. The company SOP which states that a co-pilot should not call 'STOP' on takeoff, may have led the co-pilot to believe that he was not expected to call 'GO-AROUND' either.

However, the commander's attention was taken up with responding to ATC and attempting to clarify if the aircraft was still cleared to land. By the time ATC had reissued the landing clearance, he had re-engaged one autopilot in CMD, but only in CWS P and CWS R modes. The aircraft, in these modes, without an input from a pilot, would have held the existing pitch attitude and heading. However, any movement of the control column and/or wheel, intentional or otherwise, would have caused a corresponding change. Following the autopilot disconnection, the aircraft deviated above the glideslope and to the left of the localiser, and this probably occurred as a result of pressure applied inadvertently to the control column by the commander.

The OM contained, in different places, conflicting instructions on the way the SOP 'five hundred feet' call was to be made. The operator has advised that the intention is for the call to be made with reference to barometric altitude, and therefore, would relate to a height above the runway threshold. The co-pilot did not appear to be aware of this and made the call based on indicated RA height. Again, the training of the co-pilot in this respect appears to have been ineffective.

When the co-pilot called "FIVE HUNDRED FLARE ARMED", the aircraft was actually only at 425 ft aal, due to the presence of the valley which runs under the final approach path for Runway 27 at EMA. This meant that the time to the runway threshold from that point, was around 10 seconds less than would be expected with the aircraft at 500 ft aal on the approach. It is possible that this reduced time may have contributed to the accident, as the point at which the aircraft reached Decision Height would have occurred somewhat sooner than the commander may have anticipated from his pre-existing mental model of the approach. Following disconnection of the autopilots, the commander did not recognise that the aircraft was no longer in the correct modes to continue the approach, although his action of re-arming the APP mode at 230 ft agl suggests that he had noticed something was amiss.

When the commander heard the EGPWS SINK RATE and PULL UP warnings and saw 'green' through the windscreen, one or both of these factors acted as a trigger for him to initiate a go-around. However, this occurred too late to prevent the aircraft from striking the ground. With no references as to their location, other than knowing they were not on the runway, the pilots' only option was to get the aircraft flying again. Whilst the aircraft was in contact with the ground, the co-pilot thought that the commander was not taking any action to control the aircraft and made a few comments before calling out 'GO-AROUND', several times. In the confusion that followed, it took some moments for control of the aircraft to be regained. The co-pilot was proactive in getting the aircraft back into the air, ensuring that full power was achieved and a safe climb established.

2.3.4 Diversion to Birmingham Airport

Both crew members were initially shocked by what had happened. However, after a few moments, they continued with their respective responsibilities: the commander resumed control and, for the rest of the flight, the co-pilot made helpful suggestions and provided him with support. The commander was assertive and clear in his requests for assistance from ATC and they responded quickly.

Flying the aircraft was difficult because of the damage it had sustained. The commander was forced to fly the aircraft manually, in a high drag configuration and to counter a continual tendency for it to roll to the left. Although he could have flown a straight-in LOC/DME approach to Runway 15 at Birmingham, he decided instead to use the Runway 33 ILS, probably to ease his workload.

2.3.5 Landing at Birmingham Airport

When the pilots received the information from the Police helicopter that the right main landing gear was not visible, it was only then that they realised that they would have to make a partial gear up landing. The co-pilot located the appropriate QRH checklist, read it out and carried out the required actions. This principally ensured that unnecessary warnings were cancelled and that the fuel supply was isolated at touchdown. The commander, after one further attempt to lower the gear by the manual system, prepared for the landing.

The video from the Police helicopter recorded the entire touchdown and landing roll sequence at Birmingham. This showed a well-executed emergency landing, with a gentle touchdown and good control of the aircraft during the roll out. The commander deliberately positioned the aircraft slightly to the left of the runway centreline and, after touchdown, kept the right engine off the ground for as long as possible. This was successful and the aircraft remained on or close to the centreline of the runway until it came to a stop.

2.4 Human factors

2.4.1 Duty schedules

At the time of the accident at EMA, the commander had been on duty through the night for 10 hrs 25 mins and the co-pilot for 9 hrs 15 mins. While these duty periods were within the allowed limits, it is certain that both pilots would have been affected to some degree by tiredness. Furthermore, the accident occurred during a low period of the circadian rhythm, a time when it is recognised that human performance may be adversely affected. This would have been true for both the pilots and the air traffic personnel. The time of night, therefore, was considered to be a factor in the accident, although it was not unusual for the pilots who were regularly employed on night operations.

2.4.2 Workload management

The commander was relatively inexperienced in his position, having flown in command for just four months and, as such, would have still been finding the task new and challenging. Being newly promoted, he would naturally have wished to be seen to be capable, and he clearly showed that he wanted to do his best on behalf of the company by his actions. On this occasion, he demonstrated his desire to operate according to the commercial preference of the company by re-confirming the preferred alternate, when a diversion was being considered, by making the decision to divert to EMA, even though it would have been easier to go to Liverpool where the weather was better.

The tasks concerning communicating with the company, planning the diversion, briefing and flying the approach, were mainly carried out by the commander. By doing his best to include and manage all the various options, he allowed his own workload to become high.

The workload remained high during the diversion and, by the time the aircraft was established on the approach into EMA, the commander had been operating under a high workload for a considerable period of time. Given that he had not been expecting fog, and the busy nature of the flight, it is possible that he had not had time to build up a good mental model of the CAT III approach environment. In particular, this may have affected his level of preparedness for the absence of any sight of the runway until immediately before touchdown.

2.4.3 Automation

During an automatic approach, the responsibility for controlling the flightpath of the aircraft is transferred from the PF to the aircraft. The pilot's role is changed to that of monitoring the autopilot. However, monitoring is not a function that is performed well by humans and so a series of safeguards are built into the procedures to enable pilots to check the correct performance of the autopilot during an automatic approach. If one of these procedural checks fails, then an action from the pilot is required; therefore the check acts as a trigger for his action. However, if an event occurs which is not part of these procedures, as happened in this case, then the trigger for the pilot is missing and a suitable response may not occur.

The commander was aware that the autopilot disconnect warning was not a system failure, but the result of his own action, and he was unlikely to have come across this scenario in training. This, together with the fact that his immediate focus was probably on the ATC call, may be the reason the warning did not act as a trigger for him to go-around. In the short period that followed, there were no further go-around triggers until the EGPWS warning sounded and the commander saw 'green' through the windscreen. Go-around action was initiated but not in time to prevent the aircraft striking the ground.

After the short period of extreme confusion, the co-pilot called for a go-around. Had he made this call after the autopilots were disconnected, this should have been a recognisable trigger for the commander, and it is considered highly likely that he would have initiated a go-around at that time.

2.4.4 Crew Resource Management

Crew Resource Management (CRM) training is intended to reinforce the fact that both pilots should be closely involved with the conduct of a flight, regardless of rank and who is the PF. The training focuses on the appropriate use of non-technical skills. One of the main tools of CRM is the existence of, and adherence, to SOPs. Effective CRM should enable a crew to manage routine and non-routine circumstances and also to overcome a situation where one pilot, for whatever reason, has lost situational awareness. This is achieved, at least in part, by task sharing and teamwork. However, most of the tasks in this flight appear to have been undertaken by the commander.

Communication and co-operation between the pilots appeared to be generally good throughout the flight, except for the 40 second period between when the aircraft was at 500 ft on the approach into EMA and when it was safely established in a climb after contacting the ground. This period started at the point when the commander deviated from the SOPs. As PF, he answered the radio call from ATC during the approach but, according to the SOP, he should have prompted the co-pilot to contact ATC to clarify the content of the call. The reasons why the commander took the call himself were probably because he thought the call must be answered immediately, as it could have affected their landing clearance. To ask the co-pilot to respond would inevitably have involved a short delay, and in a situation where time was critical. Also, the commander had a very good command of English, whereas the co-pilot did not.

The time from the autopilot disconnect to the impact with the ground, was 27 seconds. During this period, the commander became distracted from his primary task of flying the aircraft and, because of this, did not recognise that a go-around was required. The co-pilot, who did recognise the need for a go-around, did not take the positive action required and call out 'GO-AROUND'. The co-pilot did make several SOP cross-checking calls after the autopilot disconnect, which went unanswered. It was possibly because the commander appeared active that the co-pilot did not act positively to his lack of initial response to the calls. The co-pilot then made the call of 'ONE DOT HIGH' followed by in French rather than English "WE NEED TO DESCEND". Following these two calls, the rate of descent of the aircraft increased until, at 45 ft aal, it passed through the glideslope with a rate of descent of around 1,500 fpm. It is possible, therefore, that the commander's actions in descending may have been in response to the prompts from the co-pilot.

There were a couple of instances during the approach when the knowledge and understanding of the co-pilot seems to have been different from the expectation of the operator.

> Therefore, it is recommended that the Belgium Civil Aviation Authority require TNT Airlines in Belgium to carry out a review of their standard operating procedures to ensure that it is clear to all pilots when go-around action is required. (Safety Recommendation 2000-010)

Once the commander had "recovered his senses" a few seconds after the impact, his authority and ability to control the aircraft returned and the co-pilot again adopted a supportive PNF role. Thus, the teamwork was re-established and the flight progressed well, under difficult circumstances, from this point.

2.4.5 Unusual circumstances

One of the main aims of the detailed training and checks that pilots regularly undergo is to ensure, as far as possible, that flight crews do respond appropriately, rather than instinctively, to both normal and abnormal situations. However, the circumstances in this case were unusual and despite his having undergone appropriate training and testing to the required standard, the commander became distracted from his task at a crucial time.

The conditions for this to occur were established over a period of time and to understand why this distraction occurred, it is considered necessary to examine how various events affecting this flight differed from other 'normal' flights.

Whilst, individually, such events may not have been of great significance, when considered collectively, they appeared to have contributed to an increase in workload and subsequent loss of situational awareness for the commander.

These events are identified as follows:

- The commander and co-pilot originally reported for duty at 1815 hrs and 1925 hrs respectively; they reported together as a crew for this flight at 0140 hrs. Although their duty periods were at a time of night when human performance can be adversely affected, it was not a particularly unusual time for this flight crew to begin a duty period as they were accustomed to night freight operations. In this respect therefore the time of night was considered a minor factor.

- The takeoff and transit to Stansted were without incident but, when the aircraft arrived in the London Stansted area, the weather conditions were worse than forecast and it was not possible, at that time, to make an approach. This required the commander to make changes to his original plan. He then made the decision to divert, the first time he had needed to make such a decision since becoming a commander and, therefore, this was considered an unusual factor.

- Difficulty was experienced, and extra time was taken, in locating the approach charts for EMA, as they were filed under N for Nottingham (East Midlands Airport). However, this was considered to have been a minor factor.

- At EMA, it was the first time that the commander had carried out a Category III approach whilst in command. This was, therefore, considered to be a major factor.

- The radio message from ATC whilst the aircraft was established on final approach, containing the phrase '…..NOT TO LAND…….' was considered a major factor.

Taking these factors all together, it is considered that the commander was likely to have been working at, or close to, his maximum capability, at the time he heard the message from ATC to the effect that his company would prefer the aircraft not to land at EMA. At this point, when he inadvertently disconnected the autopilots while trying to clarify the message, he probably became overloaded and was no longer managing the aircraft. This resulted in his loss of situational awareness and control of the aircraft's flight path.

2.5 Air traffic control Nottingham East Midlands Airport

The approach of OO-TND into EMA was normal until the company representative contacted the Tower by telephone with a message for the aircraft. The message, which was heard by the controller (ADI), sought to know if it was possible for the aircraft to land at EMA and the caller said that the company would prefer the aircraft to land at Liverpool. At this stage, the aircraft was on final approach and had been given clearance to land. Given that this was at a critical point in the flight, particularly so in the prevailing weather conditions, the most prudent action would have been for the ATC personnel to have taken no action and allowed the aircraft to land.

In a situation where there are intensive aircraft movements, it is likely that the ADI would not respond to such company requests. However, in the early morning, with only one aircraft on approach, there was a marked contrast between the workload of the flight crew, which was high, and that of ATC, which was relatively low. The ADI would have had no difficulty in listening and responding to the request. His initial reaction was that only the crew in the aircraft would know if it was possible for the aircraft to land and, understandably, he wanted to assist the company if possible. This desire prompted him to make an instant decision to call the aircraft and give the crew the option of landing or diverting. Given the position of the aircraft on final approach, he needed to provide the information quickly and did so using terminology that he considered clear. Unfortunately, the crew were not native English speakers and the message contained terminology that was not standard ATC phraseology. The result was that the commander of the aircraft responded after a short delay with an attempt to query whether the transmission was for his aircraft, and disconnected the autopilot in the process.

It would be difficult to preclude operator's representatives from calling the Tower with 'company' messages for their aircraft, as there may be messages that must be forwarded to the crew, regardless of the aircraft's position. However, as the aircraft approaches to land, any such messages should be increasingly related to safety, and transmitted in strict compliance with normal ATC terminology. In the situation involving OO-TND, the timing of the incoming message from the company was unfortunate. The decision by the controller to agree to the company's request, by transmitting the message to the crew at such a late stage in a CAT III approach, was inappropriate, and the controller appeared to have had reservations about making the call. He then seems to have realised that he should not have passed the message as, when the commander queried the call, he corrected himself and re-issued the clearance to land.

Since the accident, an amendment to MATS Part I has been published. This now advises controllers to ensure that any transmission of a company message will not compromise safety and will not cause a distraction to pilots at a critical period of flight.

Any approach in weather conditions which require an automatic landing should be considered a critical period of flight.

After the ADI heard the aircraft climb away, he thought that the go-around may have been the result of his earlier transmission. This was reinforced by the crew asking for a diversion to Liverpool Airport. He spoke to the crew, in a relatively long transmission, telling them that he had heard them go-around and asked them whether it was in order to divert or due to the weather. In the circumstances, this was unnecessary and put added pressure on the crew at a time of high workload, although the controller was unaware that the aircraft had struck the ground and had been seriously damaged. The Watch Supervisor was alerted to a possible problem with the aircraft, having sensed that the crew may have had a problem, because of their use of the word 'Standby'. Following the commander's declaration of the emergency, the actions by the ATC controllers, particularly the Watch Supervisor as the Radar Controller, were prompt and effective. This eased the workload on the flight crew by providing diversion information and flight path instructions.

During a subsequent runway inspection, the landing gear leg was not found. This was, understandably, due to the poor visibility, and the fact that no comment had been made by the crew concerning the circumstances of their touchdown.

2.6 Air traffic control at Birmingham Airport

When it was apparent that an ILS approach for Runway 15 was not going to be available, after verifying the extra distance and thus time that making an approach to Runway 33 would require, the commander requested Runway 33 ILS. At around this time, the controller realised that the police helicopter operating over the city of Birmingham could possibly be of use in establishing the external condition of the aircraft before it landed. The commander was offered an inspection, which he accepted. The information from the helicopter was subsequently of use as it established for the pilots the status of the landing gear, enabling them to read through the appropriate checklist.

To ensure that the aircraft would pass near enough to the helicopter, it was necessary to vector it towards where the helicopter was operating. This did not involve any extra track miles but did place the damaged aircraft directly over the populated area of the city. In most cases, this would be undesirable with an emergency aircraft but, without doing this, the pilots would not have had the benefit of the extra information regarding the landing gear.

2.7 Meteorological data analysis

The meteorological forecast seen by the pilots did not predict the presence of fog. The lowest visibility at Stansted was forecast to be 4,500 m, with broken cloud at 700 ft, but with only a 30% probability of this occurring. At EMA, the forecast was for a visibility of 10 km or better, with a 30 % probability of it reducing to 8 km. This gives rise to the question as to why the visibility deteriorated to such low levels from that forecast.

The UK Met Office provided a post-accident analysis of the forecast, and their reasons for the actual conditions. This analysis is summarised below:

> *'There was a possibility of fog which was considered to be low risk (10% to 20% probability) and more likely to affect areas to the north of EMA. The Met Office has previously included low probabilities of fog in their forecasts but, in accordance with ICAO requirements, is no longer required to include probabilities of less than 30% in a TAF.*
>
> *Areas of Strato-Cumulus and Alto-Cumulus cloud over the south-east and the midlands were expected to prevent general fog formation. This cloud was extensive but contained gaps which were slow moving and of considerable size. The presence of this cloud is thought to be the reason why BHX weather remained CAVOK, however, an equivalent amount of cloud covered Stansted Airport as well. It is thought that the fog at Stansted may have formed under a gap in the cloud layer and subsequently drifted across the area. EMA may have suffered from fog as a result of some large gaps in the cloud cover but this would have been very difficult to predict in advance.'*

The accuracy of forecasts is understandably limited. However, there was a notable discrepancy between the logged automated RVR readings and the promulgated METARs, TAFs and ATIS broadcasts for EMA. For example; the EMA METAR and ATIS H, both issued at 0420Z, gave a visibility of 1,600 m. At 0434Z, the EMA TAF was amended to a visibility of greater than 10 km, with a temporary reduction to 1,600 m between 0400Z and 0800Z.

None of these reports reflected the actual conditions; the RVR recorded at 0420Z was 400 m at the start of Runway 27. Thus, although information about the deteriorating visibility was available, it was not incorporated as required into the meteorological bulletins and SPECIs were not generated. Had the fog only been very shallow and not affecting meteorological visibility, then a SHFG (shallow fog) code should have been included in the METAR.

This situation seems to have occurred because the system at EMA at the time of the accident was not set up to include RVRs in the METAR and the ATIS, if the meteorological visibility was recorded as being above 1,500 m. This was not in accordance with the requirements published in MATS Part 1. The Met Office was not aware of the actual conditions at EMA because the METARs were incorrect and therefore the TAFs produced at this time did not reflect the change in conditions that had occurred.

It was not until the 0450Z METAR and 0506Z revised TAF were issued that the actual conditions were reflected, more than an hour after a significant deterioration in visibility had occurred. While this did not directly affect the outcome of this flight, it is undesirable that RVR information should have been available but not incorporated into the relevant meteorological reports.

2.8 Airport Authority

Airports are commonly filed in on-board chart books under their names, not the ICAO identifiers. The name change of EMA was made for reasons not related to aircraft operations. However, although not considered to be a very significant factor, this accident demonstrates that a change such as this may have an unexpected impact upon flight operations. The original name of an airport is often retained for some time in common use, and it is not unusual for airports to be known by several names at any one time.

3 Conclusions

(a) Findings

1. The flight crew were properly licensed and medically fit to conduct the flight.

2. The flight crew flew the aircraft within the operator's normal Flight Time Limitations scheme limits.

3. The performance of both pilots may have been adversely affected by tiredness, as a result of the combined effects of their overnight periods on duty and the low point in their circadian rhythm.

4. The flight crew conducted their pre-flight planning thoroughly, taking into account the work in progress at Stansted and the weather forecasts for southern England.

5. A number of unusual events, from the flight crew's perspective, occurred during the flight prior to the accident, which contributed to an increased workload and their subsequent loss of situational awareness.

6. The weather forecasts for southern England did not correspond to the actual conditions. The possibility of fog or weather conditions, which would prevent an approach at Stansted or require a CAT III approach at EMA, was not forecast and was not a planning consideration for the crew.

7. The aircraft's documentation was in order and there were no outstanding defects recorded in the technical log.

8. The aircraft was loaded with sufficient fuel for the intended flight.

9. The aircraft was serviceable up to the moment it struck the ground at EMA.

10 Following deterioration of the weather conditions at Stansted, the decision to divert to EMA was taken in good time, and allowed for a possible second diversion to Liverpool Airport.

11. Additional pressure was placed upon the crew during the transit to East Midlands Airport as excessive time was taken to locate the approach plates as these were filed under N for Nottingham East Midlands Airport.

12. The weather conditions at EMA were such that a CAT IIIA approach and landing was required.

13. The recorded automated RVR at EMA was not incorporated into the latest weather reports, although it was passed to the pilots by ATC.

14 The CAT IIIA approach was the first to be carried out by the commander in actual conditions in the aircraft since he had been promoted from co-pilot some four months previously.

15 The aircraft intercepted the ILS to Runway 27 normally and became established on both the localiser and the glideslope by approximately 2,000 ft aal.

16 At a late stage in the approach, at around 530 ft aal, ATC transmitted a 'company message' to the aircraft, to the effect that they did not want the aircraft to land at East Midlands Airport. At the discretion of the crew, they were approved by ATC to go-around.

17 The commander's attempt to respond to, and clarify the contents of, the call from ATC, late in the approach, was an inappropriate action for the Pilot Flying.

18 In his attempt to clarify the ATC message, the commander inadvertently disconnected the autopilots.

19 The commander's attempt to re-instate the autopilots whilst replying to ATC was an inappropriate action and not in accordance with the company CAT III SOPs.

20. In attempting to reinstate both autopilots, the commander only succeeded in engaging one, and only in CWS P and CWS R modes.

21. The OM did not specifically state that a co-pilot should call GO-AROUND if he felt uncomfortable during an approach, although it was the operator's expectation that he should.

22. The co-pilot did not appear to have understood that he could make the call for a go-around.

23. The commander did not initiate a go-around until the EGPWS sounded a SINK RATE PULL UP warning at a radio altimeter height of between 87 ft and 59 ft, and he saw the green colour of the grass ahead.

24. The go-around was initiated too late to prevent the aircraft striking the ground. It made contact in the sterile grassed area to the left of Runway 27, abeam the threshold.

25. During the ground contact, the right main landing gear detached from the wing, causing damage to the right flaps and the loss of hydraulic System A.

26. After striking the ground, there was a short period of confusion on the flight deck, after which the commander resumed control as the aircraft climbed.

27. The flight crew had no knowledge of where the aircraft had struck the ground.

28. The aircraft was flown to Birmingham Airport with the nose and left landing gear down, and with the trailing edge flaps stuck at 32º and 40º, left and right, respectively; this produced a tendency to roll to the left.

29. The Runway 15 ILS glideslope transmitter remained switched off at Birmingham Airport following maintenance.

30. The commander decided to accept a longer route in order to be able to carry out an ILS approach for Runway 33.

31. The longer route to Runway 33 allowed an opportunity for the police helicopter to inspect the aircraft. In order for this to be done, the damaged aircraft flew over the city of Birmingham.

32. The inspection by the police was helpful to the pilots.

33. A successful partial gear up emergency landing was made at Birmingham.

(b) Causal factors

1. ATC inappropriately transmitted a company R/T message when the aircraft was at a late stage of a CAT III automatic approach.

2. The commander inadvertently disconnected the autopilots in attempting to respond to the R/T message.

3. The crew did not make a decision to go-around, when it was required, after the disconnection of both autopilots below 500 ft during a CAT III approach.

4. The commander lost situational awareness in the latter stages of the approach, following his inadvertent disconnection of the autopilots.

5. The co-pilot did not call 'go-around' until after the aircraft had contacted the ground.

(c) Contributory factors

1. The weather forecast gave no indication that mist and fog might occur.

2. The commander re-engaged one of the autopilots during a CAT III approach, following the inadvertent disconnection of both autopilots at 400 ft aal.

3. The training of the co-pilot was ineffective in respect of his understanding that he could call for a go-around during an approach.

4 Safety Recommendations

Although the circumstances of this event could easily have led to a catastrophic accident there are few safety recommendations which can be made. This is because actions by individuals which contributed to the accident were either inappropriate or were not in compliance with existing procedures. Non-compliance with procedures, whether inadvertent or deliberate, can be difficult to prevent and can only be addressed by effective training and maintaining a culture of adherence to SOPs within an organisation.

A large proportion of the operator's flying programme was carried out at night. Operational tasks carried out at night are subject to a greater number of human errors, because of the limitations of human performance. It is particularly necessary in these circumstances, therefore, that the operating procedures are robust and well understood by all concerned. This will help to ensure that when errors are made they are detected and appropriate corrective action is taken.

One of the causes of this accident was the lack of a decision to go-around when it was required. Therefore the following safety recommendation is made:

4.1 **Safety Recommendation 2008-010:** It is recommended that the Kingdom of Belgium Civil Aviation Authority require TNT Airlines in Belgium to carry out a review of their standard operating procedures to ensure that it is clear to all pilots when go-around action is required.

5 Safety action

The timing and content of the message passed by ATC to the aircraft when it was at 500 ft, was inappropriate and distracted the commander at a critical phase of flight. The revision to MATS Part 1, already underway at the time of the accident and effective from 31 July 2006, has addressed this problem. However, the CAA considers that it may be possible to give more specific guidance as to when messages may be passed, and proposes to undertake a study of this issue by establishing a working group.

The absence of RVR data in the METARs from East Midlands Airport around the time of the accident meant that forecasts for the area were not updated for several hours and did not reflect the actual conditions. The meteorological reporting system at EMA was upgraded in April 2007. The new system provides for automatic reporting of weather information, including RVR data, within the required criteria. Therefore, it is considered that this safety issue has been addressed and no safety recommendation is made.

P T Claiden
Inspector of Air Accidents
Air Accidents Investigation Branch
Department for Transport
March 2008

TNT	NON-NORMAL CHECKLISTS LANDING GEAR	NNC.14-11 Rev 3 01-08-2005

MANUAL GEAR EXTENSION TNE

Condition: All landing gear do not indicate down and locked when the landing gear lever is placed in the DOWN position or the landing gear lever is jammed in the OFF position.

Airplanes with overhead landing gear indicator lights:

OVERHEAD LANDING GEAR INDICATOR LIGHTS .... CHECK

If three green landing gear indicator lights are illuminated:

Land normally.

■ ■ ■ ■

If the overhead landing gear indicator light for the affected gear is not illuminated:

Continue with this checklist.

LANDING GEAR LEVER .... OFF

MANUAL GEAR EXTENSION HANDLES .... PULL

[The uplock is released when the handle is pulled to its limit. The related red landing gear indicator light illuminates, indicating uplock release.]

Wait 15 seconds after the last MANUAL GEAR EXTENSION HANDLE is pulled:

LANDING GEAR LEVER .... DOWN (if possible)

[Red landing gear indicator lights remain illuminated if landing gear lever is not down.]

If all landing gear indicate down and locked:

Land normally.

■ ■ ■ ■

If a green landing gear indicator light still fails to illuminate:

WHEEL WELL LIGHT SWITCH .... ON

Continued on next page

 PART B, AEROPLANE OPERATING MATTERS B737

NON-NORMAL CHECKLIST

Landing Gear

NNC.14-12	NON-NORMAL CHECKLISTS	TNT
Rev 3 01-08-2005	LANDING GEAR	

Continued from previous page

If a green landing gear indicator light still fails to illuminate: (continued)

GEAR DOWN LOCK VISUAL INDICATOR(S) .... CHECK

[Verify main landing gear mechanical down lock indicators are aligned and nose landing gear arrow heads are in contact.]

If the gear down lock visual indicator(s) verify gear down and locked:

Land normally.

■ ■ ■ ■

If one or two landing gear are not down and locked:

Accomplish the PARTIAL OR GEAR UP LANDING checklist.

■ ■ ■ ■

If all landing gear remain retracted:

Accomplish the LANDING GEAR LEVER JAMMED IN THE UP POSITION checklist.

■ ■ ■ ■

NON-NORMAL CHECKLIST

Landing Gear

TNT | NON-NORMAL CHECKLISTS
LANDING GEAR | NNC.14-13
Rev 3
01-08-2005

PARTIAL OR GEAR UP LANDING

Condition: All landing gear do not indicate down and locked after attempting manual gear extension.

Note: When applicable, for main landing gear, check secondary indications for illumination.

Brief crew and passengers on emergency landing and evacuation procedures.

Burn off fuel to reduce touchdown speed.

Plan a flaps 40 landing.

Set VREF 40.

-----------------------------DEFERRED ITEMS-----------------------------

==> DESCENT

Recall..Checked

AURAL WARN C/B (P6)..Pull

[Prevents warning horn with gear retracted and landing flaps selected.]

AUTO SPEEDBRAKE C/B (P6)..Pull

GND PROX WARN C/B (P18)
(on airplanes with only FLAP INHIBIT switch)......................PULL

GROUND PROXIMITY FLAP/GEAR
INHIBIT switch (as installed)..........................FLAP/GEAR INHIBIT

GROUND PROXIMITY GEAR
INHIBIT switch (as installed)..............................GEAR INHIBIT

Autobrake..OFF

STANDBY POWER switch...BAT

Landing data...................................VREF40, Minimums ___

Approach briefing... Completed

Continued on next page

 | PART B, AEROPLANE OPERATING MATTERS | B737

NON-NORMAL CHECKLIST
Landing Gear

NNC.14-14	NON-NORMAL CHECKLISTS	TNT
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Continued from previous page

----------------------------DEFERRED ITEMS----------------------------

==> APPROACH

Altimeters .... ___

Available landing gear .... Extend is desired

Engine BLEED AIR switches .... OFF

[Ensures the airplane is depressurized at touchdown.]

APU switch .... OFF

Landing Procedure .... Review

- Position fuel pump switches OFF just prior to flare.
- After stop, accomplish the EVACUATION checklist.

Note: Do not raise the speed brakes unless stopping distance is critical.

----------------------------DEFERRED ITEMS----------------------------

==> LANDING

ENGINE START switches .... CONT

Speedbrake .... DOWN detent

Landing gear ....___ DOWN

Flaps .... 40, green light

■ ■ ■ ■

B737	PART B, AEROPLANE OPERATING MATTERS	© TNT

NON-NORMAL CHECKLIST

Landing Gear